The Foundry Trade Journal

AND

PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 8. MARCH, 1906. No. 51.

—PUBLISHED—
THE FIRST WEEK IN EACH MONTH BY

EAGLAND & Co., Ltd.

165, STRAND, LONDON, W.C.

Devoted to the interest and advancement of the Iron, Steel and Brass Foundry Trades.

Subscription Terms: 7s. 6d. per annum, post free.

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THE FOUNDRY TRADE JOURNAL,

165, Strand, London, W.C.

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THE "STUD" IN PIPE-FOUNDING.

THE introduction of cast-iron as a material for the manufacture of pipes dates back to a very early period in the history of iron founding.

The free use of cast-iron pipes has solved many of the difficulties which had to be faced by our municipal authorities in the development of our large cities. We have only to mention water, gas, and sanitation, and the use for these pipes become apparent. Cast-iron possesses many of the qualities which go to form a perfect material for underground pipes.

Pipes made from cast-iron have many advantages which those manufactured from other materials, such as fire-clay and stoneware, do not possess, and it may with truth be predicted that these latter materials will be superseded ere long by cast-iron for this purpose, except under special circumstances.

The advantages of cast-iron pipes are being more recognised every day; in fact, some of our municipal authorities have already framed bye-laws relating to underground pipes for sanitary purposes prohibiting the use of any material other than cast-iron.

One of the principal reasons in favour of cast-iron is that stoneware and fire-clay, owing to the brittleness of the material, will not allow of the joints being properly made, and when a settlement takes place in the ground in which they are laid the joints open and allow the gases and other matter to escape, thereby defeating the purpose for which they were intended. Proper joints, on the other hand, can be made with cast-iron pipes, and they are consequently less affected by movements of the ground. From a sanitary point of view, therefore, the use of cast-iron pipes is advisable. Cast-iron is probably more extensively used for the manufacture of pipes than for anything else.

In many foundries the making of pipes is the principal business; and there are few foundries which are not called upon from time to time to make a pipe in some form or other.

It is our intention, in this article, to deal with an important improvement in the manufacture of cast-iron pipes.

Our remarks will be chiefly confined to rain-water, soil, gas, and water pipes, which are cast either horizontally or with a slight gradient; they do not apply to pipes which require to withstand high pressure, such as those used for hydraulic purposes, which are cast vertically.

The improvement we are to discuss revolutionised the cast-iron pipe trade some 40 years ago, and it is still extensively employed in pipe manufacture, we refer to the introduction of the "Stud."

FIG. 3

FIG. 2

FIG. 1

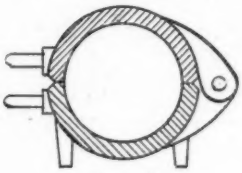


FIG. 6

FIG. 4

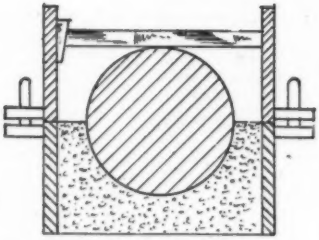


FIG. 5

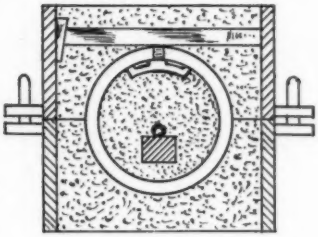


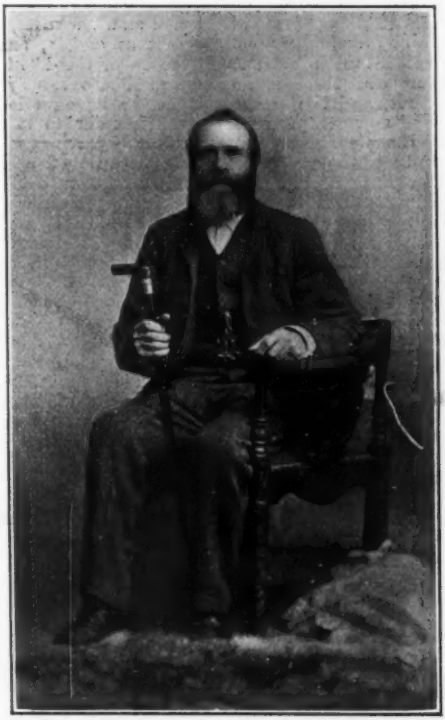
FIG. 7

This invention has been of great advantage both to employers and employed; to the employer it has caused a great saving in the cost of production; the moulder has less trouble and worry; while the risk of bad castings has been reduced to a minimum. To appreciate the advantages of the "Stud," we must consider the method adopted prior to its introduction. Previously the "Nail and Bar" method held the field. In employing this, the moulder placed a wooden bar about 1½ in. square in the middle of the top part of the moulding box, 1 in. from the body of the pipe. When the box was rammed up and parted a nail with a broad flat head was passed through the mould, and driven into the wooden bar far enough to allow a part of the nail, equal to the thickness of the pipe, to project into the mould. When casting, the head of the nail prevented the core rising above the thickness of the metal required.

Up to this point the method served very well, but trouble afterwards arose. When the boxes were emptied, it was found that owing to the iron coming in contact with the nail the latter became red hot; in consequence, it burned part of the bar into which it was fixed, which necessitated the moulder taking all the bars out of the boxes and turning a new face to the new mould, for the part burned away would not hold a fresh nail. In the course of every four days the wooden bars became useless, and had to be replaced.

The plant also was damaged by this method; for unless the bars were cut exactly to the size of the box, in most cases the sides of the box were damaged

in the attempt to ship them. The "Nail and Bar" method was used for many years, until the late Mr. John Reid invented the "Stud." Mr. Reid was for more than 30 years foreman moulder to Messrs. Shaw & McInnes, Firhill Iron Works, Glasgow, the well-known makers of cast-iron pipes, and it was while in the employment of this firm that the invention was made. Like many other inventors, Mr. Reid reaped no profit from his invention. Had he patented it, he would doubtless have made a fortune, for its utility was at once recognised, and the "Stud" was adopted in all the pipe foundries in the country. Ever since it has been constantly in use, and hundreds of tons of pipes are manufactured by this method every week.



THE LATE MR. JOHN REID.

The stud is a small piece of screwed wire, equal in length to the thickness of the metal of the pipe. The diameter varies from about $\frac{5}{16}$ths of an inch for the smallest, to about $\frac{3}{8}$ in. for the largest size of pipes (see Fig. 1). The other parts are a cast-iron bar slightly shorter than the width of the moulding box (see Fig. 2); an iron wedge to fix the bar into the box (see Fig. 3), and a saddle for the core (see Fig. 4).

The parts are fixed as follows:—After the bottom part of the mould has been turned over and the top part placed in position, the iron cross-bar is wedged exactly into the middle of the box, one of its sides bearing on the pattern (as shown in Fig. 5). The box is then rammed up and parted. When the pattern is drawn, the mould is ready to receive the core. Into the core—which is made in the usual two-part hinged pipe core-box (see Fig. 6)—is placed the saddle. The saddle has a small flat boss in the centre about $\frac{3}{4}$ in. in diameter. The boss is placed in the core-box so that the flat disc will appear on the outside of the core

when complete; and when placed in the mould will come exactly below the cross-bar in the top part of the box. Having got the core into position, the stud is placed in the centre of the exposed disc; the mould is then closed, and ready for casting (Fig. 7 shows a section through a pipe mould with all parts in position). In casting the iron first fills the bottom of the mould, and presses the core in an upward direction. The core is kept in its proper place, however, by the stud, which comes into contact with the cross-bar in the top part of the box and also rests on the saddle, an equal thickness of metal being thereby maintained around the pipe. The stud itself is cast in the pipe, but owing to it being threaded there is no danger of its coming out, and it is quite as strong and will stand as much pressure as any other part of the pipe.

It has been found to be quite practicable in making the smaller sizes of pipes to have the cross-bar (Fig. 2) cast into the moulding box, thereby saving the time necessary in the adjustment and wedging of the bar for each new mould.

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BLOWHOLES IN STEEL CASTINGS.

By J. Hughes.

The term "blowhole" is an arbitrary one, assigned to the cavities found in varying quantities, and in more or less degree in cast steel, *i.e.*, steel that has been brought to the fluid condition and allowed to cool; they do not occur in steels manufactured by the now rare processes which involve only the plastic condition of the product, as steel puddling, etc.

This definition accepted, we see at once that it is in the melting and casting of steel that blowholes are acquired. In discussing the subject, then, we are restricted to the field of melting and casting, a field which, at the present day, is sufficiently wide, forsooth.

Ever since the inception of steel casting as an industrial art, the problem of blowholes has been, and still is, one of the greatest confronting those concerned. The united efforts of founder and metallurgist have been brought strenuously to bear upon the solving of the problem, with a view to either eliminating them or preventing their harmful effects.

Much has been done; yet, to-day, it is the biggest bugbear in every steel foundry of the author's acquaintance; it is the bone of contention between workman and foreman, and likewise between foreman and manager.

What work has been done has been directed chiefly towards the study of the chemical and physical properties of blowholes, and their formation and behaviour under varying conditions of the manufacture of steel intended for steel ingots, *i.e.*, for comparatively large masses of steel of regular shape, and varying little in thickness from end to end, and nothing in cross-section at any given point.

As applied to steel castings of irregular shape and thickness, however, the matter is not so simple, and the old maxim of "the upper third" of the ingot only being unsound is obviously not applicable, and it is the lamentable lot of almost every steel founder to have seen many large and costly castings wander on to the scrap heap because of a little group of blowholes, situate on or near to a boss or other working part, irrespective of that part being at the top or bottom at the time of casting, his sorrow being, of course, deepened by the fact that all his time and labour had been spent on the casting only to have the defect revealed by the first few cuts of the machine, owing to the peculiarity that blowholes have of never, or, rarely ever, coming to the surface, which, again, is due to the freezing of the skin of metal adjacent to the walls of the mould. This recalls a point of necessity often overlooked in the machine shop of machining all vital parts first, as far as possible.

We are sometimes told that the difficulties due to blowholes have been surmounted. No steel founder would dream of making such a sweeping statement, or of accepting one in any way approaching it.

The foundation for the statement is to be found in the fact that the workers alluded to have done such sterling work from a purely metallurgical and experimental point of view, in showing the conditions under which steel acquires blowhole-forming tendencies, and how to prevent its doing so. As we have said, however, looked at from a foundry point of view, the question has its own peculiar significance, apart from that of well-melted steel. The subject of blowholes in steel castings, even in its most practical sense, is a chemical one; and without some chemical knowledge to assist him in forming his opinions, it is useless for the foundry expert to attempt to combat the evil, for, as I shall endeavour to show, even granted a competent metallurgist and good steel for every heat, the source

of trouble is not removed; though, let me say in passing, that the metallurgist, the principal factor in the foundry problem, is often a minus quantity of the staff.

Keeping in mind the great volume, and "paper possibilities" of the subject in hand, I propose, very briefly, to set before my readers the nature and source of blowholes, avoiding, as far as possible, any scientific terminology likely to fog the minds of the unitiated.

Molten steel, as a liquid, behaves, like other liquids, as a solvent with respect to gases, dissolving them with avidity. This is not to be wondered at, when we consider that, at a low red heat, *i.e.*, in the solid state, pure iron will occlude, or take up and retain, when cold, over four times its own volume of carbon-monoxide gas.

Air, as a gaseous mixture, is also capable of solution. These gases may be in solution when the metal leaves the furnace; air may be drawn in during the operation of casting and dissolved; gases not present on tapping may be formed before casting, by chemical reaction in the mass, and, during or after casting, by chemical reaction due to contact with the mould. We can, therefore, roughly classify our sources as :—

(1) Dissolved or occluded gases.

(2) Air dissolved or mechanically held.

(3) Bodies solid or liquid gasified after tapping.

As the solution of gases is a function of the temperature required to raise the metal to the necessary fluidity for casting, the trouble is greater in the case of the dead, soft variety of steel used for the majority of castings than in the medium and high carbon steels used for other purposes.

It is pretty safe to state that all blowholes must come from one or other of the above sources. Whatever the source of dissolved or occluded gas, it is rejected by the steel on cooling, except in such quantities as the homogeneous metal is capable of retaining in solution or in any other form. In the tall vertical mould of the ingot caster, much of the released gas escapes by the ordinary way of gravitation, ascending in a steady stream of bubbles, or, in the case of a "wild heat," with a violent boiling effect. In the case of steel castings, this is obviously impossible, except in a very few cases, and attempts are, therefore, made to rid the metal of all gases before tapping, and also before casting.

With regard to (1) the addition of high silicon irons to the furnace mixture, and of aluminium or ferro-aluminium to the ladle, is now the universal practice in steel foundries, since silicon, and in greater degree aluminium, possesses the property of eliminating the gas or preventing its liberation. The theories (as yet published) relating to the action of these bodies, are somewhat vague and uncertain, and need not be discussed here, the main points to be considered from the practical founder's point of view being as to how far they are effective in producing the desired result. That their use is not always attended with success is certain. And it is for the founder to discover how far this is due to his own shortcomings. With regard to (2) the importance of ridding the mould of air is at once apparent, and is, indeed, one of the first precautions taken by the moulder in the preparation of a mould, though probably not so much to prevent blowholes as to prevent a blown or hollow casting, which is not the same thing. Nevertheless, in casting large masses of steel, the drawing in of air and the lack of facilities for escape, is a great factor in the case of blowholes in such castings; hence the necessity, wherever possible, of casting from the bottom, so as to permit the rising body of steel to push away the enclosed air, which finds its way out through the vents and spaces provided for the feeding heads. Where this is not possible, the necessity for porosity of structure in the mould, particularly near the face, is to be emphasised.

One of the commonest errors into which the steel moulder falls is that of "finishing" his mould too well. The moment his pattern is drawn, he seizes his "swab brush" and saturates the more or less broken mould with water; he then proceeds to apply his various hard steel tools with great vigour as if to make the polish on the mould rival that of the tool employed, the polish of which tool he is generally proud. There is more than one evil in this practice. In the first place, if the mould is properly rammed and ironed, and the facing sand efficient, no more tooling is required than is necessary to give to the mould the correct shape; moreover, the mould loses its virgin shape, which it never regains, and, consequently, the resulting casting is not true to pattern. Again, the pores of the mould are effectively closed, by undue polishing, against receiving the refractory wash or "paint"—a very serious matter. And, lastly, to return to our subject, the natural porosity of the "compo" is counteracted, with the result that more air is confined in the mould than need be, and though the moulder

may have provided sufficient vents for the ultimate escape of the air, much damage may be done. So far as (3), the gasification of bodies, is concerned, apart from the metal, moisture is undoubtedly a very potent factor in the case. The steel founder is brought up, and rightly too, to stand in awe of moisture, probably not so much with a view to preventing blowholes, as from a consideration of a blown and wrecked mould, coupled with that of his personal safety.

It must be remembered, however, that very carefully made analyses of the gas found in blowholes, and published from time to time, show that it contains hydrogen varying in quantity from, say, 50 to 90 per cent.

Now, with the exception of the small amounts of hydrocarbons existing in producer gas, there is no other source from which hydrogen can be derived, except from moisture either charged into the melting furnace with the raw materials, or with the air used for combustion, or picked up after tapping.

Assuming moisture to be present in the mould, it would be, at the high temperature of casting, immediately dissociated into its constituent elements, according to the well-known equation, $H_2O = H_2 + O$, the oxygen appropriated by some friendly element, such as carbon, shown in the following equation $2C + O_2 = 2CO$, and the active hydrogen molecule, set free in the nascent condition. This shows the extreme importance of a good drying system, and of every precaution being taken to ensure that the mould, once dry, is kept so.

It is a common practice in many foundries to close moulds on Saturday for casting on Monday. At all times, and especially in damp or foggy weather, there is condensation going on, and an appreciable quantity of moisture may readily and unnoticed settle in the mould; whilst in the case of imperfect drying all enclosed steam quickly recondenses. The wisest are those who arrange to cast warm, as far as possible, as many an imperfectly dried mould has been successfully cast while still hot; skin drying, in small work, is an example of what is possible in that direction.

Where any doubt exists, and, indeed, always in the case of heavy work, a good plan is to return the closed mould to the drying stove for a few hours previous to casting, so that any moisture, condensed or otherwise, on or near the surface of the mould, is driven by evaporation and expansion either out of the mould or into the vents, and away into the cinders.

By leaving "drying vents" at various points of the mould, and inserting a *perfectly dry* and bright steel wire into the vents as soon as the mould is drawn from the stove, all doubt is removed at once, as any moisture in the body of the mould quickly condenses on the cold steel.

The question of gases formed by combustion of the surface of the mould is one of great interest, since in the mould facings most commonly used (carbonaceous) the gas which must inevitably be formed is one which is an extremely active agent in the formation of blowholes, though absent itself in any quantity in the blowholes themselves; the gas referred to is carbon-monoxide (CO).

In the classification of refractory materials, graphite or similar forms of carbon are referred to as neutral, carbon being an element incapable of forming salts, like silica on the one hand, and alumina on the other, under the conditions of casting, but invariably, at furnace temperatures, forms a gas. Under some conditions of casting, however, that is just what is not required.

One very important point is often overlooked by foundry metallurgists, namely, that when steel is tapped under certain conditions of temperature, which has resulted from an abnormal condition of removal of the metalloids, and quite irrespective of the amount of *active oxide* in the slag or ferrous oxide in the metal, the addition of physics, such as manganese, silicon, aluminium, etc., fails to bring about the chemical reactions resulting in the removal of oxygen from the oxygenated and almost carbonless steel, and that it is only when the temperature has fallen below the limit that the reaction occurs. When no regard is given to the temperature of casting (and very little is given, the chief concern being to get the metal into the waiting mould) this point may be reached only when the metal makes contact with the cold mould and a violent ebullition is the result, and taking place, as it does, in an atmosphere charged with the gaseous oxides of carbon, the latter are free to work what damage they may, and, as we have already said, carbon monoxide gas is an active agent.

Modern tendency is to replace the carbonaceous mould with one less chemically active, not only in respect to wash, but also in the "facing" itself. The substitute is a very siliceous mixture, consisting practically of pure silica sand, in admixture with fireclay of the purest quality, the mixture itself containing well

over 90 per cent. of silica, the bulk of which is in the free or chemically uncombined condition; the wash also is strictly siliceous, so that we have a mould which, apart from steam, should not generate gas at all, and any possible danger from that source is avoided. The practice is, however, not as general as it will become when the above-mentioned facts are more clearly recognised. It goes without saying that the siliceous mould is theoretically the most perfect, and the more siliceous it becomes the more refractory, though, at the same time, physical difficulties are introduced, which are being slowly but surely mastered. It may be urged that there have always been carbonaceous moulds in the history of steel castings; that is true, but there have always been, and still are, blowholes, in spite of "physics," and it is to show to the founder causes and possible precautions, and also to prompt thought and action in all concerned, that this article is written.

The crucible steel melter (the first in the field) is comparatively exempt from the trouble for obvious reasons. The conditions under which he melts approach very nearly the experimental, in the sense that he works in small quantities, each pot being either a small charge of its own, or a small unit of a whole, and in any case can be given individual attention and rejected if unfit. His materials are purer, and the melting is done almost out of contact with air and fire gases. The metal, when melted, is held, under the eye of the melter, to absorb silicon from the pots, and, aided by manganese, free oxide is absorbed into the slag as silicates of iron and manganese, the state of the slag being the true index of the "kill"; the moment this is right the pot is hauled off and cast. His castings are usually small, and much of his work is submitted to subsequent mechanical treatment. The open-hearth founder taps in quantities of 10, 20, and 30 tons or more, and "mass action," an almost unknown quantity, has to be contended with. Moreover, where the crucible melter's process is very largely an operation of melting only, the open-hearth melter not only melts, but makes steel, the operation embodying all the complex reaction of pig boiling or puddling, large volumes of gas being generated within the bath, which gas is again carbon monoxide—a significant fact.

The users of the pneumatic processes have still another condition of things to face. Owing to the very high temperatures obtainable, sharper and more extenuated castings are possible than with other processes, but the difficulty above mentioned of controlling the killing reaction is greater, and, what is more relevant to our subject, atmospheric air in great volumes is forced for 20 minutes or more through the bath of molten iron. A slight overblow results in the impregnation of the mass with oxygen in the form of diffused oxides, the removal of which, it is well known, is the object of the addition of the various antidotes.

I wish here to again call attention to the question of hydrogen. Undesiccated air, of course, contains moistures varying in quantity with the humidity of the atmosphere, which varies much even during 12 hours, and very much over longer periods. This means that hydrogen is constantly being carried into the body of the bath, a condition of things which does not obtain in other methods of manufacture.

Much passes out in the converter gases, as shown by the spectra of the flame, but in all probability much is retained. After a long experience with the pneumatic processes, Bessemer and Tropenas, the author feels convinced that the question of moisture in the air used for blowing is not one to be passed over, though he is not at present prepared to state that the trouble (other conditions being constant) increases or decreases with the humidity. The question of the desiccation of the blast has certainly been proposed, but never thoroughly exploited.

The same condition of things, of course, obtains in the ordinary Bessemer process, in which many of the blowholes are eliminated, and others (for the most part clean and unoxidised) are removed, or, rather *hidden*, by mechanical treatment at the rolls.

A little consideration and a better knowledge of the above facts concerning the causes of blowholes in the foundry should lead to improvements among practical men, and should certainly tend to remove the great element of doubt and mystery which positively surrounds the question, and since the treatment and prevention is so uncertain, and the effects so far-reaching, any light on the subject must always be of great value.

Electric welding, however efficient, is a very costly and unsatisfactory substitute for a definite solution of the problem of elimination, and in the absence of the welder, it is not to be wondered at that so many firms failing to economically produce their own steel castings have to turn in dismay to the specialist.

A NEW "HIGH-PRESSURE" BLOWER.

THE STURTEVANT ENGINEERING COMPANY have introduced a new form of positive-pressure blower. It consists, like other positive blowers, of two revolving cylinders mounted on parallel axes and meshing with each other, contained in a housing in which they revolve with only sufficient clearance to avoid rubbing friction. The motion of the rotors creates pockets or chambers between them, which pockets increase and decrease in size, so that air is drawn in through suitably disposed ports, is compressed, and is then discharged through other ports in the housing. The pressure of the entrapped air acts on the leading side of each rotor and opposes its rotation; power must be applied to the rotors to turn them against this one-sided pressure. The shafts of the two rotors are geared together, outside of the housing, to make the rotors revolve at equal speed. Usually, one of the shafts is connected to the source of power, and in turn drives the other rotor through these gears.

The new Sturtevant blower has the peculiarity that the work of moving and compressing the air is done wholly by one rotor, and the other rotor takes only the power needed to overcome its journal friction. The gears which connect the shafts are thus relieved of all but a small fraction of their usual duty, and the machine operates with correspondingly reduced noise and increased efficiency. The construction of the "high-pressure" blower, as it has been called, is shown in Fig. 1, giving transverse and longitudinal sections of the complete machine. The impeller consists of three longitudinal blades surrounding a cylindrical core; but as this core has a part of its circumference cut away where the circumference of the idler intersects it, the core must be stationary instead of rotating with the blades of the impeller. The blades are therefore carried on a radial web-plate mounted on the middle of the shaft; three blades project from either side of this web. The core is necessarily made in two parts, because of the impeller web; each half forms an inward extension of the corresponding end plate of the casing.

The idler is a cylinder containing three deep longitudinal slots or chambers of suitable form to receive and pass the blades of the impeller as the rotors turn. The openings of these slots on the idler periphery are made as narrow as possible; when a slot faces the impeller shaft the stationary core of the impeller case completely covers the slot opening and prevents direct communication between suction and pressure sides.

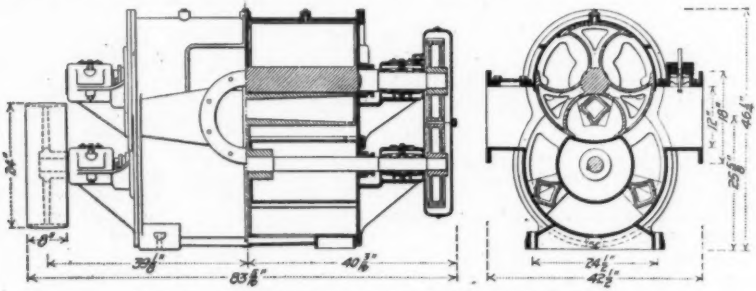

FIG. 1.—TRANSVERSE AND LONGITUDINAL SECTIONS.

In Fig. 2 are represented, by diagrammatic sections through the blower, three successive stages in the operation of the machine. The stationary parts (casing and impeller core) are drawn in black, while the impeller blades and the idler are cross-hatched. The segmental areas L, M, N, O are depressions in the end plates, which in certain positions of the rotors serve as air ports which are important in the working of the blower.

In section I, Fig. 2, the inlet pipe at the left is open to space D, between impeller blades A and B, which space is closed off as soon as impeller A reaches the lower edge of the inlet opening. If the speed of rotation is so great that space D is not filled to atmospheric pressure by the time it is closed off, then additional air will flow through the depression or "leakage port" L into space D, until the position of section II. is reached, where port L is just cut off. Continuing just beyond this position, impeller

blade B uncovers the leakage port M, which brings space D into communication with the delivery side, as shown in section III., and permits air under delivery pressure to flow back through port M into D, and thus partly compress the charge in D. This is indicated by the dotted arrows at port M in section III. This compression continues until impeller blade B reaches the lower edge of the delivery opening, after which blade A sweeps the charge in D out into the delivery pipe. This stage is represented by the condition of space E between blades B and C in section I. Here the slot Z of the idler is coming into position to receive blade C. Shortly after this stage the port O makes leakage connection between slots Z and Y, and pressure air from Z flows into Y, thereby compressing the atmospheric charge in Y. In section II. the end of this stage is nearly reached; just afterwards slot Z is completely closed off by the impeller core. The remaining flow through port O from Z to Y reduces the pressure in Z, so that when Z opens to the delivery side, as in section III., wasting its contents into the inlet opening, the loss of compressed air is lesseened by the amount which Z previously gave to Y.

Thus the work of compressing air is done wholly by the impeller blades A, B, C. The idler acts only as a valve or air block to pass the impeller blades back into the delivery space, and in doing so actually returns compressed air to the inlet side. This loss is reduced, of course, by making the size of the slots X, Y, Z a minimum; in other words, making the idler as small as possible compared with the rotor.

Two general styles of the machine are built; in one the idler and impeller lie in the same vertical plane, the idler being above (as shown in Fig. 1), while in the other type they are in a horizontal plane. The machine is of cast iron throughout, except for the steel impeller shaft. The idler and its shaft are a single piece of cast iron. The blowers are reversible, running equally well in either direction. This explains why the leakage port N, Fig. 2, is provided, though it has no function when the machine is running in the direction there shown. When it is desired to maintain the delivery pressure quite constant, a relief valve is fitted on the delivery side (see Fig. 1). For transferring gases and air at high pressure, stuffing boxes for the shafts are provided in the end plates.

These blowers can operate over a wide range of speed. They are intended to work up to pressures of 10 lbs. per sq. in. They are built for capacities up to 15,000 cu. ft. per min., for which latter the length of the impeller is about 71 in., and the speed 250 r.p.m. Such a blower will supply a 90-in. cupola, melting 30 tons of iron per hour.

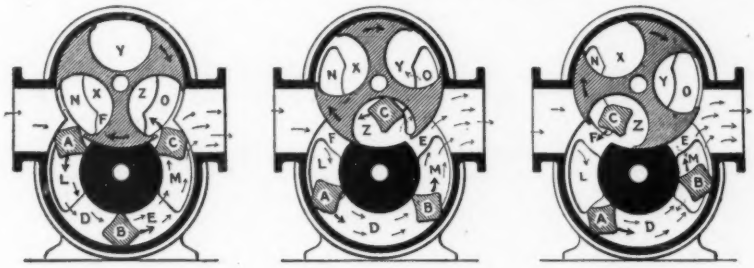

FIG. 2.—DIAGRAM SECTIONS TO ILLUSTRATE THE OPERATION.

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GERMAN SYNDICATES FOR STEEL CASTINGS.

I.—The Dusseldorf Combination.

A SHORT time ago the German Imperial Home Office authorities presented to the Reichstag a memorandum dealing with the results of the official inquiry into the working of many of the trade syndicates existing in that country. In the course of the document reference is made at some length to the two combinations of producers of steel castings, as represented by the Düsseldorf Steel Castings Syndicate (Stahlformguss Verband of Düsseldorf), and the Upper Silesian Steel Castings Syndicate (Stahlformguss Verband der Oberschlesischen Werk, of Gleiwitz).

The information given in regard to these organisations, it should be initially explained, has emanated mainly, if not wholly, from the Syndicates themselves, which placed the particulars before the Home Office authorities during the inquiry.

The statutes of the Düsseldorf Syndicate, whose organisation in this respect is being overhauled, show that it differs from the Steel Syndicate's in the sense that the production is not fixed under the old agreement, whatever arrangements may be made under the new one. Thus, the combination limits itself to the distribution of orders received by apportioning them among the members on the basis of the productive capacity of each works. A method of distribution exists which becomes modified when the membership increases or decreases. In the case of foreign trade it is provided that with the exception of Luxemburg and Switzerland, the export market is open to the members. In regard to inland sales, members have to conform to the minimum prices fixed by the Syndicate's current price list, and exceptions to this rule are only made in certain specified cases.

The general agency of the Syndicate assumes the control and ensures that the regulations of the Syndicate are carried into effect. For this purpose each member has to furnish to the agency every week a complete list of the orders obtained and the contracts concluded during the week, while once a month an account has to be rendered of the total deliveries to each purchaser, together with a statement of the weight and the amount of the invoices. The agency then communicates the totality of the sales to all the works in order that each of them may be able to ascertain whether it is in advance or in arrears in relation to its quota, and so that it may regulate its future sales; and the delivery figures are also placed before all the works at the same time.

On the occasion of the settlement at the end of the year the works which have exceeded their quota have to pay into the funds of the Syndicate an amount equal to 2½ per cent. of the value of the excess, whilst the works which have not reached their quota receive from the combination 2 per cent. of the value of the quantity necessary to make up the deficiency. The agency has to grant to those works which have remained materially below their quota a favourable turn in the case of official contracts, or other orders to be divided. In order to facilitate the apportionment of orders, each member of the Syndicate who proposes to tender has to inform the agency, immediately after having taken note of the specification, in order that the agency may be able to fix the participations and prices. The statutes make provision for the imposition of fines for breaches of the agreement; the fines are fixed by the managing Council of the Syndicate, and members may appeal from the latter's decisions at the general meetings. Securities or bills have to be deposited by members as a guarantee of their engagements. In the event of differences arising, the services are to be obtained of the Court of First Instance at Düsseldorf, and not those of an arbitrary tribunal, as in the case of other syndicates.

II.—The Silesian Castings Syndicate.

The Upper Silesian Steel Castings Syndicate, which was first established in December, 1903, for a period of two years, was recently prolonged to December 31, 1908, with headquarters at Gleiwitz. It is composed of (1) Eisen und Stahlwerk Bethlen-Falva, of Schwientochlowitz; (2) A. Borsig, Berg und Huttenverwaltung, Borsigwerk; (3) Actiengesellschaft Ferrum, of Zadodzie, near Kattowitz; (4) Ganz & Company, of Buda Pesth, for their works at Ratibor; (5) Konigliches Huttenamt, of Gleiwitz and Malapane; (6) Kania and Kuntze, of Zadodzie; (7) Vereinigte Konigs und Laurahutte, of Konigshutte; and (8) the Kattowitz Actien Gesellschaft fur Bergbau und Eisenhuttenbetrieb, of Hubertushutte, near Oberlagiewnik. The manufactures placed under the control of the Syndicate are enumerated in a current price list, and apply to the German Empire, including the free ports, and the Grand Duchy of Luxemburg and Switzerland. As exemptions from the Syndicate are cited (1) castings intended for war material and artillery; (2) castings made for individual consumption or for manufacturing purposes in a member's works or shops with the object of being sold; (3) wheels for mine and portable railways, wheel sets and accessories; and (4) malleable castings to be sold at least 10 per cent. higher than the Syndicate price. With regard to the second exemption, the statutes provide that the Konigliche Huttenwerke, of Gleiwitz and Malapane, shall have as their special customers the State Works in Upper Silesia, the Royal Salt Works, at Schonebeck, Inowrazlaw, Duerrenberg, Bleicherrode, and the Stassfurt Mine Inspection Department; the special market of the Bethlen-Falvahutte is to be the industrial establishment belonging to

Prince von Donnersmarck; while the sole preserve of the Kattowitz Company is represented by the Preussen Collieries and the zinc mine of Mariagrube. In the case of orders undertaken for districts outside the sphere of the Syndicate, the member concerned must make sure that they are really intended for abroad. If required by the Syndicate, the member has to furnish proof that the castings have been used abroad, but if the proof is not forthcoming the order is considered as being for the home market.

The participation of members in the orders has been settled by a scheme which establishes the proportion according to which the orders are to be apportioned among the constituents. If a new member is admitted, the denominator common to all the proportions which express the respective participations is increased by the quota granted to the new member. On the other hand, if a member withdraws, the common divisor is reduced by the allotment accorded to the retiring works. The Syndicate acts through the intermediary of an agency. The agency has to conform to the terms of the statutes, and is the legal representative of the Managing Council of the Syndicate and the members in regard to third parties or the members themselves in all contentious questions, or other matters affecting the combination.

As to the distribution of orders the statutes stipulate for the forwarding by members, on forms provided, of weekly returns to the agency giving a complete list of orders and contracts concluded during the week, and a monthly list of deliveries, giving names, weights, and invoice prices. The total declared sales are to be communicated to the members in order that each may be able to judge whether he is in advance of his allotment, and may therefore regulate his sales in the future; and the delivery statistics are also to be similarly intimated. At the settlement at the end of each year the works which have exceeded their quota have to pay 5 per cent. of the value of the excess to the Syndicate's bank, while in cases of sales not having attained the allotment the works concerned receive 4 per cent. of the value of the deficiency from the funds of the Syndicate. This regulation may be modified in regard to the figures at a general meeting by a majority composed of four-fifths of the number of voters. The works considerably below their permissive output are to be favoured by the agency in the case of public or limited adjudications or in that of other orders to be given out, but the agency has as far as possible to take into account the old relations existing between works and clients. In order to facilitate the distribution of orders, any works desiring to take part in a public contract letting has, after noting the specification, to advise the agency so that the latter may be able to arrange the apportionment and prices, having regard to quotas, the situation of the accounts, the offers and the geographical location of the works. The protective price must exceed at least by 5 per cent. the price of the works which is to receive the order.

The expense of working the agency is met by quarterly contributions on the part of the members, forwarded before the middle of the month following the end of the quarter. The amount of the impost is 1 per cent. of the invoice price (net at works) of the quantity delivered during the quarter. In addition to providing the working expenses, the sums thus received may be utilised according to decisions of the Managing Council. The decisions of the latter are to be unanimous, or if not the matter is settled at the general meeting of the members, which also has to decide upon the imposition of a supplementary levy in the event of the annual receipts not balancing the general expenses. The syndicated works deal directly with clients; they have to comply with the prices and conditions of sale fixed in the Syndicate's current price list, and they are not permitted either directly or indirectly to offer advantages of any kind to their customers. The prices in the Syndicate's list are the minimum, and it is therefore open to members to demand higher rates. As to the question of transactions between members, prices are not fixed, but the sellers have to declare and pay the usual 1 per cent. contribution on the turnover. If it should be desirable in the interest of the Syndicate to make sacrifices owing to foreign or native competition, the members by previous understanding with the agency are authorised to fix lower prices than those contained in the current price list. But when exceptional prices are proposed the works are to get an agreement with the agency before making offers or concluding contracts.

The affairs of the Syndicate are administered by a Managing Council composed of four members, who elect among themselves a President and a Vice-President, and who are elected yearly at the ordinary meeting of the Syndicate. By means of a majority of two-thirds, the general meeting may appoint one or more

confidential controllers who, either alone or in company with the general agent, may exercise a regular surveillance over the declarations furnished by each works, and the works undertake to produce books and documents relating to steel castings for the inspection of the agent and the controllers, who are pledged to professional secrecy in respect of everything except cases of irregularity. It is necessary, in order to render valid decisions arrived at in general meeting, for all the members to be present, or for them to have been invited at least a week previously by means of a registered letter, mentioning the matters for consideration. But the non-observation of these formalities is without importance when all members are in attendance.

The votes granted to the constituent works are as follows:—Ganz & Company, 3; Konigliches Huttenamt, 3; Vereinigte Konigs und Laurahutte, 2; A. Borsig, 2; Kattowitz Bergbau und Eisenhuttenbetrieb, 1; Bethlen-Falva, 1; Actien Gesellschaft Ferrum, 1; and Kania and Kuntze, 1. These make a total of 14 votes. The decisions arrived at have to be by an absolute majority at the general meetings, and they are binding upon all the members, whether absent from the meetings, or not represented, or only represented by a party not fully accredited. Any breach of the statutes or of the resolutions adopted at the general meeting is liable to a fine of £5 for each infraction. If a transaction is completed at a lower price than the fixed price the member concerned is liable to a fine of ten times the difference between the two prices, but in any case it cannot be less than £5. A violation of the agreement in regard to price is considered to have been committed if evasion is sought by rebates, facilities given in the conditions of payment, bonuses, purchase of old materials contrary to the conditions, and combinations with other offers, affairs, or transactions. It is also provided that with the exception of the Royal Iron Works (Konigliche Huttenwerke), the constituents shall deposit money or equivalent guarantees with the President for the due performance of their obligations, and that arrangements shall be made for the continuance of membership should all or portion of a works be disposed of to a third party, the fine for contravention being £500.

Mutual Agreements.

An agreement exists between the Düsseldorf Steel Castings Syndicate and the Upper Silesian Steel Castings Syndicate, which recognises the provinces of Silesia and Posen as a "zone of protection" for the works in Upper Silesia. As a consequence the constituents of the Düsseldorf combination undertake not to compete in Silesia or Posen except at "protective prices" exceeding by 7½ per cent. the minimum rates charged by the works in Upper Silesia. The common zone—that is, where the two organisations can compete at equal prices which are those enforced by the Düsseldorf Syndicate—comprises the kingdoms of Saxony and Bavaria (excluding the Rhenish Palatinate), the provinces of Brandenburg, Pomerania, and the East and West of Prussia. The remaining zone of the syndicated region is considered as a zone of protection for the works outside of Silesia, or in other words, the Silesian works are only permitted to deliver to that zone at a price 7½ per cent. higher than the minimum fixed by the Düsseldorf Syndicate. A further arrangement provides that the Upper Silesian Syndicate, in regard to its deliveries in the common zone or abroad, shall have a certain definite share in the total deliveries of the Düsseldorf combination—the share on January 1, 1904, was 2.57 parts out of a total of 128.81 parts. An indemnity is payable according as the Silesian sales exceed the fixed share, or do not reach the quantity represented by it. In conclusion, it may be mentioned that the Upper Silesian Syndicate has become a party to the agreement existing between the Düsseldorf Castings Syndicate and the Austro-Hungarian Iron and Steel Syndicate in the matter of mutual respect of markets in the sale of castings.

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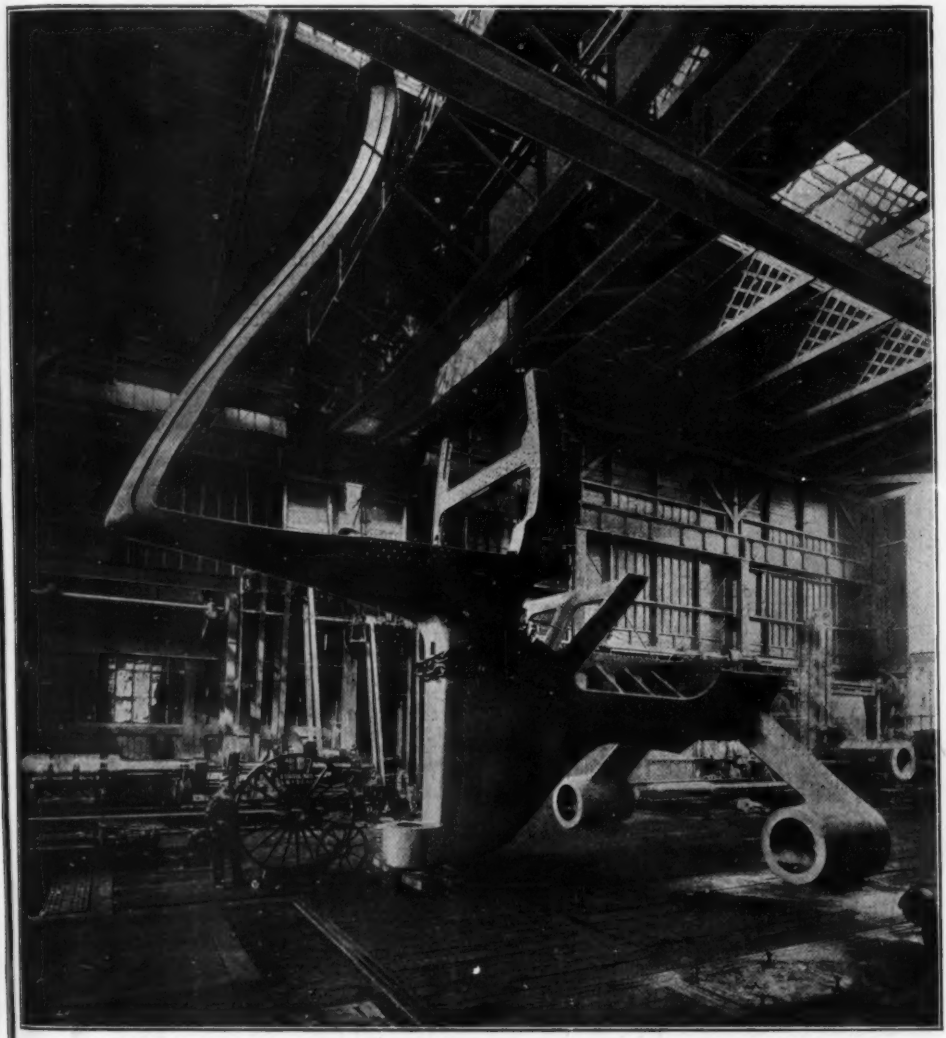
STEEL STERN FRAMES FOR THE NEW CUNARD LINERS.

THE annexed photographic illustration gives a striking view of the stern frame and screw propeller brackets for one of the new liners which the Cunard Steamship Company is having built for its transatlantic trade. The vessels, which will be equipped with turbine engines, will be 800 ft. long, 88 ft. broad, will have a moulded depth of 60 ft., and a displacement of 43,000 tons. The contract speed is 24.5 knots, which is to be actually maintained from port to port as one of the conditions of acceptance. It is probable, however, that the trial speed will run up to 25.5 or even 26 knots. One of these vessels is being built on the Clyde

by Messrs. John Brown & Company, and the other at the Wallsend yard of Messrs. Swan & Hunter.

lington Forge Company, by whom they were cast. These pieces are by far the largest constructed for any ship. The



VIEW OF STERN FRAME AND BRACKETS FOR ONE OF THE TWO CUNARD TURBINE STEAMERS NOW IN COURSE OF CONSTRUCTION.

The illustration represents the steel stern frame and brackets for the Cunarder which is building on the Clyde. They are shown erected in the shops of the Dar-

stern frame alone, in completed condition, weighs 47 tons, and about 70 tons of molten metal were required to cast it. The after brackets, shown attached to

the stern frame casting, were cast singly, and each one of the pair weighs 22½ tons. The forward brackets (the Cunarders are quadruple-screw vessels) each weigh 24 tons. The rudder will be a truly enormous affair, its stock being 26.8 in. in diameter, and its weight when finished and fitted to the ship will be 70 tons. The weight of the stern frame, as shown in our illustration, is 100 tons, and the aggregate weight of the rudder, stern frame, and four brackets will be about 220 tons. It took two months to make the mould in which the stern frame was cast, and six months more to complete the finished castings. The height from the bottom of the rudder blade to the top of the stern casting is 55 ft.

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THE BRITISH OPEN-HEARTH STEEL INDUSTRY IN 1905.

The British Iron Trade Association has ascertained by returns supplied by the makers that the output of open-hearth steel ingots in the United Kingdom in 1905 was 3,879,748 tons, which compares with a production of 3,245,346 in 1904 and with a production of 3,124,083 tons in 1903. The increase of output in 1905 over 1904 was 634,402 tons, which is the largest advance made in any one year since the open-hearth steel industry was founded about 1865. This increase has been distributed over every one of the leading districts. Scotland has increased the output of 1904 by 174,581 tons; the North-East Coast by 172,358 tons; North and South Wales by 132,360 tons; Sheffield and Leeds by 42,518 tons; Lancashire and Cumberland by 35,476 tons; and Staffordshire, Lincolnshire, etc., by 77,109 tons.

The production of open-hearth basic steel ingots in 1905 has been 795,238 tons, which is an increase of 133,174 tons on the output of 1904, an increase of 284,429 tons on the output of 1903, and an increase of 388,458 tons on the output of 1902. The output of plates and angles in 1905 was 1,765,111 tons, or 308,965 tons more than in the previous year. Scotland in both years was the most important producer, followed in 1905, in the order of their importance, by the North-East Coast, Wales, Staffordshire, etc., Sheffield and Leeds, and Lancashire and Cumberland.

The total output of steel and tinplate bars in 1905 was 839,415 tons, which compares with an output of 662,024 tons in the year 1904. In both years the greatest output under these joint heads was reached in Wales, which figures for 70 per cent. of the whole in 1904, and for 74 per cent. of the whole in 1905. The next largest output in 1905 fell to Staffordshire and Lincolnshire.

One of the features of the trade of 1905 was the virtual monopoly by Wales of the production of tinplate bars. Of this product, the tonnage produced in North and South Wales in 1905, at twelve different works, was a record figure. In no other district was any quantity of tinplate bars produced worth speaking of. The production of steel bars other than tinplate was 228,144 tons, the largest output of which was in Scotland. But it will be clear, from an examination of the figures, that in Scotland generally the demand for plates and angles, and the provision made for supplying that demand, were the predominant features of the trade—so much so that about 70 per cent. of the total make of ingots, including loss in conversion, was absorbed in the manufacture of these products.

The returns collected in the spring of 1905 showed that there were then 510 open-hearth furnaces erected in Great Britain, of which 345 had been in operation during the year 1904. During 1905 the average number of furnaces in operation was 383, while the total number of furnaces built remains substantially the same as in the previous year. The average output of ingots per furnace in operation was 9,400 tons in 1904 and 10,130 tons in 1905. Of the total furnace equipment of the country, 376 are built for the acid process and 138 for the basic, making a total of 514. Twenty-one new furnaces were being constructed in 1905, and 131 furnaces were either unemployed or very occasionally employed in that year.

The output of steel ingots per furnace has shown in 1905 an increased output of 730 tons on an average of the whole country, and in some individual cases remarkably good practice was got over the year. Three works averaged over the year an output of 20,000 tons of ingots per furnace; one other leading works in Scotland averaged 15,200 tons; and a third establishment, with an exceptionally large output, averaged 11,300 tons.

In open-hearth basic practice 12,100 tons per furnace was got, taking an average of the five principal works in Scotland and Cleveland.

FOUNDRY PRACTICE.*

By Wm. A. Bole.†

My foundry experience has been confined to the making of engine castings, cylinders, flywheels, valves, and other such castings, both for steam engines and for gas engines, ranging in sizes from small to very large.

Castings of this class are very much machined; they are penetrated by the planer, lathe, and drill press, and still they must be steam tight and gas tight after all this is done. Such castings are in distinction to many other classes, where a good, sound outward appearance suffices to obtain acceptance and where this inquisitorial work is unnecessary.

From my general relation to the manufacturing problem, I feel more interested in the ultimate sufficiency of a casting than in the first cost of making it.

It is, of course, common custom to make test specimens attached to, or poured from, the same metal as our large castings, and we are obliged to place reliance upon such test pieces, as they are perhaps the best method of obtaining knowledge which we can employ, but we all know that test bars alone are not sufficient assurance against treacherous castings, and that they do not pretend to reveal such dangers as internal strains in complicated castings, which often have far more to do with the value of the casting than has the quality of iron out of which the casting was poured.

It is of great importance for any man to have a certain repetitive experience which we call specialisation, and it is almost equally important to have a fair fund of collateral knowledge in order to supplement the first sort. This will increase his reasoning powers and make him a more active student of cause and effect. The foundryman can very well afford to know some other things besides the daily round of his duties, and I believe that foundrymen nowadays, are, as a rule, inquisitive, studious men, who are doing their best to increase their fund of knowledge. Not all men are built this way, however; I remember once having a very competent machinist ask me if wrought iron was made out of cast iron, or if cast iron was made out of wrought iron, and how it was done.

The present-day aids to the foundryman are much greater and more extensive than they were some years ago. Engineers are paying closer attention to foundry methods, assisting the foundryman where they are able to do so, and tending to make his work easier and more sure. Formerly there seemed to be a distaste for foundry details, and many a design has been made where the engineer in charge spent much time and labour in going over his drawings, his engineering calculations, and his preliminary estimates, but as for the carrying out of the foundry work, depended wholly and absolutely upon the empirical experience of his foundry foreman, trusting entirely to the judgment of the latter for every move in the carrying out of the work, never going near the foundry himself.

I think, too, that the advent of the steel casting has had something to do with this change; it has always seemed to me that people engaged in the steel business have been a sort of a brotherhood, willing and anxious to exchange views and to help the other fellow out of a tight place, and this spirit, added to the additional field for the use of the reasoning powers, has tended to make the iron foundry business less of a sealed book than formerly.

There is no possible doubt as to the value of discussions in regard to foundry matters by people who have any experience with the subject, and we, all of us, ought to be of a mind open to conviction and without too much heed for consistency with our past views.

In the conduct of the iron foundry of which I have had charge for some years, I have endeavoured to induce as much reasoning and thinking among the foremen as possible, and in order to have some nucleus, or nest egg, around which to gather reflections, I prepared a little treatise some years ago, which I called our "foundry primer," being written by an infant for the use of the infant class, and liable to contain some infantile ideas; however, even an infant's mind is better than no mind at all, and it is possible that such a mind may develop into that of a grown adult, and I propose to read to you some extracts for your consideration.

Notes on Foundry Practice.

The following memorandum is intended solely for our own foundry foremen, and is issued with the knowledge that it may be in contradiction to some of your opinions on the subject, in order that such points may be discussed and combatted in the general interest of

* Abstract of a Paper read before the Pittsburg Foundrymen's Association, Feb. 5, 1906.

† Manager of Works, Westinghouse Machine Co.

finally arriving at definite conclusions in regard to foundry practice.

It is more or less beyond dispute that for every sort of defect in iron castings, more than one opinion can be advanced as to the reason, and in complicated cases there are likely to be as many reasons as there are persons. There are many circumstances which can conspire to produce bad results in foundry practice, and there is practically only one way to produce good results, which is by having every feature of our practice perfected. The difference between what will produce a good casting, and what has produced a bad one, is often small, and it is therefore important that no consideration connected with moulding or pouring castings should be considered too small to be worthy of the foundryman's consideration.

For the benefit of our own organisation, and for no other purpose, the following memorandum is issued:—

Use of Scrap.

It is the writer's belief that almost any pig-iron is improved by remelting, especially if its sulphur content is low in the first instance. Raw pig-iron is likely to be very high in carbon. There are two forms which carbon may assume in iron castings, namely, the graphitic form, in which the carbon separates out from the iron into large flakes like plumbago, and which have the effect of separating the particles of the metal, insulating them from each other, and tending to make the iron soft and weak. The effect of remelting the iron is to reduce the amount of this graphitic carbon. When iron is melted and in the ladle, the carbon in the iron assumes the form of combined carbon, otherwise if it remained in the graphitic form it would float off on top of the iron as slag, being very much lighter than the iron itself. In the act of cooling part of this carbon remains in combination with the iron, and is known then as combined carbon, tending to make the iron hard and white, while the larger portion of it goes back into the graphitic stage, with which appearance you are familiar. The principal difference between iron and steel lies in the fact that steel contains no graphitic carbon, and a rather high percentage of combined carbon, depending upon the purpose for which the steel is intended. It is really the presence of graphitic carbon which makes the pig-iron to be iron instead of steel. In an open-hearth steel melting furnace the carbon is burned out, and the iron changes from pig-iron into steel. Therefore, each remelting of the pig-iron, if it could be done with a fuel containing no sulphur, would be one step toward making steel out of your cast iron.

This tendency of the carbon to become graphitic is useful for some purposes and harmful for others. In fact, it might be fair to state that there is no such thing, properly speaking, as impurities in iron—the sulphur, phosphorus, manganese, and silicon, bear about the same relation to pig-iron that pepper, salt, mustard, and vinegar do to the food we daily eat. Each one of these elements has a certain effect upon the iron, and, rightly employed, they do good instead of harm. They must, of course, be controlled or there will be bad results, just as though too much salt had been employed in an otherwise very nourishing and palatable dish of food. The tendency of graphitic carbon to form while the iron is cooling makes thin castings soft where otherwise they might be too hard to machine, and if very thin castings are to be poured, such as novelty work and the like, it might be said that the iron could not be too high in graphitic carbon. If this same iron, however, were poured into thick and heavy sections, the result would be carbon flakes so large and so separating the grains of iron one from another, as to make the iron soft and weak, with a tendency to be porous and spongy in the centre and unsuitable for any such work as engine work. The remelting of the iron tends to reduce this graphitic carbon, and, therefore, scrap, being remelted iron, is profitably employed where the castings are thick and heavy, in order to close up the grain of the iron and make the metal solid and strong, even where it is quite thick in section. This is equivalent to saying that scrap should be used more carefully and sparingly in thin castings, and used freely and in considerable quantity for large and heavy work, the only danger in the case being that each remelting of the iron is likely to increase the sulphur content. It is not always safe to use too much scrap of unknown character, lest the sulphur run too high. In cases where the castings must be particularly clean, close grained, and hard, as, for instance, cylinders for steam and gas engines, it will be advantageous to use a very considerable quantity of scrap, and if the gates and sprues and pig bed of the previous heats can be collected and saved for this purpose, the results will be better than though any raw pig is employed. This use of scrap iron should be employed rather to improve the quality

of the iron than to simply cheapen the cost. If this improvement in quality is constantly kept in mind, it will lead to scrutinising the scrap to reject any pieces which are obviously unfit to use, such as burned iron found in grate bars, annealing boxes, and the like; all bolts, nuts, or other wrought iron or steel pieces, should be picked out of the scrap pile, and not allowed to enter the cupola or air furnace.

Requirements of Castings.

Before any statement can be made in regard to the proper iron to use, the foundryman must know what is the character of the casting which is to be made. Probably no question is more vital than the question of size, that is, its thickness as affecting its rate of cooling. It is an absolute impossibility to find any one iron which is suitable at the same time for very heavy and very light work, and to employ metal from the same ladle with which to pour a casting whose average thickness is 2 in., and another casting whose average thickness is ¼-in., is a foundry absurdity, and should be so considered and recognised by the man in charge. The iron which will make the large casting close, solid, strong, and reliable, will make the small casting hard and flinty and impossible to machine.

Conversely, the iron which will make the small casting soft and suitable for its purpose, will be likely to make the large casting open, spongy, weak, and with great tendency to shrink in the thick spots, and, in general, produce bad work. Therefore, the difficulty of running a general foundry, in which both light and heavy work are to be cast on the same day, and out of the same cupola, is very considerable. If the foundryman has nothing but light work to cast, he should use irons which are low in sulphur, fairly high in phosphorus, and high in silicon. These qualities will give him softness, and at the same time sufficient strength for almost all ordinary purposes.

If, on the other hand, the foundryman is making only large and heavy work, where soundness and strength is demanded, he must necessarily employ an iron harder in its quality, and this is to be produced by using metal comparatively low in silicon, lower in phosphorus, and may contain considerably more sulphur than would be permissible in the light castings. This is one of the reasons why foundries running on specialities have much better results with their castings than general foundries making, or attempting to make, both classes of work. We should, as far as possible, use a different cupola for our light and medium work which we wish to come soft, from that employed for our large and weighty pieces, which require a different metal to be charged in order to meet their peculiar requirements.

Of course, the cupola, as a melting furnace, is capable of being charged with different grades of metal, which must be tapped in the sequence in which it is charged, and a fair approximation may be had to what is wanted, provided the foundry foreman is very careful to stipulate just what he wants charged, and in the proper order, and provided also he taps and pours this metal in the precise order which he had intended when making up the cupola charge. It is probable, however, that the metals do not all melt in precisely the order in which they are piled in the cupola and certain of the irons may melt too early or too late to take their proper place in the procession of events. In case special iron, either light or heavy, but different from the average iron of the heat, is desired, it is best to charge such special iron on the first coke bed, and pour it off before the general run of the mix is tapped.

If this statement of the difference between requirements for large and small castings is true, it involves a careful separation of such parts and a careful planning on the part of the foundryman as to the order in which his moulds will be ready to pour, so that he may put the iron intended into the mould intended, and not get the wrong iron into the wrong mould. Cupola-melted iron is likely to be not thoroughly well mixed, and as an illustration, two or three irons might be melted in the same charge, and might be tapped out into the same ladle, but for want of stirring might be in the same condition as milk newly-poured into coffee, that is, there might be a stratification of the various metals, and as the coffee is stirred up with a spoon, so it might be well to stir the iron up vigorously to produce a uniformity and amalgamation of the ingredients which would tend to better results. For important work it is apparent that melting iron in the air furnace is superior to the practice of melting it in the cupola. In the air furnace the iron can be rabbled or stirred, and thus made to thoroughly intermingle, and, in addition to this, the tendency to boil itself produces a stirring and intermingling of the ingredients, which always results in a stronger and

more homogeneous iron. This rabbling, however, should not be done with steel or wrought iron bars, as is often the case. These bars will sluff off, and the wrought iron, having a much higher melting point than the cast iron, will not thoroughly mix with the latter, but is likely to be carried along simply in suspension, or as slag would be carried on the top of the iron, except that in this instance it probably floats with the metal, being of about the same density. It occurs to the writer that the spotted and mottled appearance of many finished castings is due to the fact that a scum of wrought iron from such cause as this has lodged against the wall of the mould and in the finishing has revealed its presence by its different colour.

It would seem to be safer practice to rabble or stir the molten metal in the air furnace by the use of wooden poles or saplings, and these latter, in addition to acting as stirring rods, produce a boiling by the sap or moisture within them, and this boiling gives the iron a chance to thoroughly mix and mingle, and possibly to rid itself of any contained impurities by the agitation.

It would be impossible to use just this same method in cupola melting, but to hold a hickory pole in a ladle of iron being tapped from the cupola ought to produce something of the same results, and the boiling in the ladle would tend not only to stir it well, but to throw off contained gases by bringing them to the surface. The use of small quantities of aluminium, about one pound of aluminium to the ton of iron, has been recommended as a means of producing this same sort of searching out of molten iron. It is alleged that the aluminium has a strong affinity for any contained oxygen in the molten metal,—this oxygen being present in the form of burned iron as the foundryman recognises it. It is well known to all foundrymen that burned grate bars, and other such iron, when charged into the cupola, are the source of a great deal of trouble, and that while such impurities create a great amount of slag, it is to be feared that part of the evil is taken up by the iron itself, although it may seem to be comparatively clean and free. The aluminium is alleged to have the property of eliminating such contained oxygen, making the castings sounder and more solid. The aluminium is very light and would float on the surface of the metal; it is, therefore, preferable to hold it below the surface of the metal in some way, and allow it to diffuse itself throughout the entire ladle.

In general, it is probably safe to say that cast-iron does not permit of softness and strength in the same iron; that softness in cast iron is always accompanied by weakness, and that strength in cast iron is always accompanied by hardness, unless the iron should be so hard as to be chilled in thin sections, and then it becomes brittle and weak from its chilled state.

The following is a table submitted as a statement of opinion of the relation which should exist between the thickness of metal in the body of a casting and the chemical composition of the iron out of which it should be poured :—

Size.	Silicon.	Phosphorus.	Manganese.	Sulphur.
¼ in.	3.25	1.00	.40	.025
½ in.	2.75	.80	.40	.040
¾ in.	2.50	.75	.50	.050
1 in.	2.00	.70	.60	.060
1½ in.	1.75	.65	.70	.070
2 in.	1.50	.60	.80	.080
2½ in.	1.25	.55	.90	.090
3 in.	1.00	.50	1.00	.100

It is, of course, understood, that this is intended to apply only to our own local practice and to nothing else.

In the case of very small castings, if we calculated their thickness on the basis of the strength of the iron, they would be so thin that the foundry would be taxed to produce them, and, generally speaking, small castings are made thicker than considerations of strength demand, simply because this action complies with the foundry requirements better. In the case of very large machinery, however, it is different, and when cylinder walls and other thicknesses run up to 2 in. and 2½ in., it is because the strength in such castings is demanded by the strain upon them, and it is somewhat unfortunate, in fact, that these large castings of thick section, by virtue of their slower cooling, crystallise into a larger structure in the act of cooling, and are not inherently as strong as they would be if poured into lighter moulds. Therefore, while it is important in the light work to select iron which is sure to be soft, it is just as important, if not more so, in the large work to select iron which is sure to be strong.

Bad Castings.

If the casting is bad, it may be for any one of several reasons. If it cracks in the cooling, it may be due to the quantity of the metal out of which it was poured, or it may be due to the haste with which it was uncovered and exposed to the cold air in cooling. The iron which will make a good casting when

slowly cooled, may make a cracked casting if the latter is pulled out of the sand too quickly, and since in our practice we are in the habit of unusual speed in pulling red hot castings out of the sand, it is particularly important that iron should be free from shrinkage tendencies, and therefore should be low in sulphur. It is unquestionably good practice to allow the castings to remain in the sand as long as possible, and if circumstances permit, until they are perfectly cold. Certain castings having unsymmetrical proportions may be aided in the act of cooling by exposing the thick places first, as, for instance, in the case of a heavy flywheel with a set of light arms, it will be advantageous to expose the outer portion of the rim and cause the rim to cool and contract more rapidly than otherwise and more nearly in time with the thinner arms.

Certain castings, by virtue of their intended use, are much more critical than others, and the iron which might be good enough for bedplates or engine housings, which do not receive much finish, and which may be cast with the critical side downward, may not be sufficiently good iron for cylinders, in which there is a great amount of finished surface, and which a comparatively small defect will cause to be rejected.

In the case of dirty castings, it may often be the case that the manner of cutting the gates is responsible for the dirtiness. The iron may enter the mould in such a way as to wash away part of the sand mould, and the sand thus liberated may fuse with the iron, forming a pasty, sticky mass, and may defy the rules of gravity and not swim to the top of the mould, but adhere to the mould wall tenaciously and allow the molten metal to surround it and pass on over it. This will result in a sandy, spongy spot, which may condemn a large and valuable casting.

It is of the utmost importance, therefore, that the foundry foreman should supervise the method and manner of cutting the gates, and not allow this to be done at the whim of the individual workman. The runner, or entry, by which the metal finds its way into the mould, is exposed to far more severe service than the body of the mould proper. In the case of a large casting it may be that 20 or 30 tons of metal is compelled to run through a narrow passage, something like a hose, and this iron, being fresh from the furnace, and intensely hot, will fuse the sand on the walls of the runner or intake, and if the sand thus fuses, it will form a glassy, pasty composition, which may be dragged along by the stream of metal to lodge some place in the mould, and generally in an important and critical place. It is, therefore of great importance that the runner or intake should be formed out of the very best sand obtainable, and carefully dried and protected by the best of facing, in order to prevent this action. For such facing, plumbago or graphite is used, because it is almost infusible by heat, being one of the most difficult materials to melt known to man. If pure plumbago is used as a facing, preferably by swabbing it on in liquid form and then drying, this makes a non-conducting covering, so to speak, protecting the sand against the heat of the iron. For pouring large and critical castings, such as cylinders, we advocate the use of fire-brick runners, in order to prevent the sand from being thus acted upon at this most critical point in the whole mould—a good fire-brick having a higher resisting power against heat than moulding sand—and if they are protected by a good coating of plumbago facing, they will endure a vast amount of liquid metal pouring over them without giving away to it. It is a universal practice in the making of steel castings, in which the molten metal is very much hotter than any iron foundry ever experiences, to use special clay runner pipes made especially for this purpose, and for the particular reason that the sand out of which the moulds are prepared, is not good enough to stand the onrush of the fresh liquid metal. We have in our own experience evidence to prove the value of making the runners in this very careful way.

As the iron is rising up in the mould, such moulds being usually poured from below, the walls of the mould are not exposed to the same furious action as the walls of the runner. The iron does not pass them with the same velocity, and is not of the same intense temperature by the time it reaches the mould proper, and, therefore, the wall of the runner gets more severe service than the walls of the mould.

There are a great many castings which have what is commonly known as a clean side and a dirty side, that is to say, one side is particular and the other one is not so much so. In consequence, the moulder who makes such castings may succeed in making a large number of passable and acceptable castings, and get into the habit of doing work in a certain

way calculated to produce results "good enough" for that class of work. The same moulder may be taken from such a job and put upon another piece of work which must be clean both in cope and drag, and if he pursues the same line of policy as he has been accustomed to, he may turn out nothing but bad castings. Therefore, it follows that a man skilled in making some one particular kind of work, may, by happy combination of processes, produce good work without really knowing which of the many things involved is accountable for his good results, and he may be put on another job no more critical than the first job, but requiring a little different line of thought, and he may produce bad work.

There are probably few departments of manufacturing in which there is as much chance work and as little absolute and positive knowledge as in the making of iron castings. This will account for the various opinions which are advanced by various experts, each equally competent in his own line, and yet radically differing from each other in his views.

Flasks and Outfit.

The making of large and important iron castings ought to be attempted only after consultation between the foundry foreman who is to prepare the mould, the pattern-maker who is to make the pattern, and the mechanical engineer, who ought to be employed to compute the stresses and pressures involved in the pouring of liquid iron, in order to make the rig strong enough without making it excessively weighty and costly. The pattern-maker should not attempt to proceed with the making of the pattern until he has consulted with the foundryman who is to do the moulding, in order that the pattern may be built on such a plan as to assist the foundryman in his mode of moulding. This involves that the pattern-maker must know a large amount of details of the foundry in order to co-operate to the best advantage, and the foundryman, on the other hand, would do well to know something of the art of pattern-making, in order that he may not ask for conditions which are antagonistic to good practice in that department.

Patterns must be made to be strong and durable, and free from tendencies to warp and twist out of shape. The pattern-maker should be the best judge as to how to construct his pattern and core-boxes to take care of this consideration, and it is obvious that each department having certain points it would wish to press, must be willing to give way to good and sufficient reasons on the part of the other. The pressures produced by liquid metal in the moulds, and the resulting strains on the parts of the mould are often tremendous, and they are generally too intricate to be readily calculated by the moulder or foundry foreman, because such calculations are more or less out of his line. Therefore, in the designing of flasks and rigging, the work of the mechanical engineer, trained along such lines as this, qualifies him to design bracing, clamping, and other means of strength, to a better and more effective degree than could be done by either the foundry foreman or the pattern-maker.

It is, therefore, apparent that a deliberate and judicious consultation among the three such officials should result in the best outfits, and as the security and safety of large moulds may depend upon the correct knowledge of the strains involved, and of the strength of parts required, the subject should be viewed from all sides before any move is attempted.

Generally speaking, the foundry foreman and the pattern-maker should determine the question of methods of moulding, and the engineer should take up the matter at this point and compute thickness of plates, flask walls, bolts, clamps, holding-down weights, and other mechanical details, as his training would best qualify him, and such rigging when judiciously made will shorten the work of moulding, increase the safety of moulding, and insure a perfection of the finished product in a way that should be gratifying to all parties concerned.

If a foundry foreman has due appreciation, therefore, of the requirements of his different classes of work as to metals necessary to produce the best results, if furnished with the metals of suitable qualities for the purpose intended, and pours these metals at proper temperatures, into moulds which are properly made and properly braced, and made of the most suitable quality of sand, protected by the best facing, the finished result ought to be a good casting, and one which we may be proud of.

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ARRANGEMENTS have been concluded between Palmer's Shipbuilding and Iron Company, Limited, and La Societa Cantieri Officiore Motori Savoia, of Genoa, for the construction of war and other ships and motor boats at the Italian company's yards. A new company is being formed with the title Cantieri Savoia Palmer, Mr. A. M. Palmer, Mr. G. Palmer, and Sir Charles McLaren being on the board.

THE FÉRY RADIATION PYROMETER.

In all pyrometers other than radiation pyrometers, there is some part—the sensitive or receptive part—which is made to acquire a temperature identical with the temperature to be measured. In the measurement of furnace temperatures, for example, radiation pyrometers are the only pyrometers which are entirely outside the furnace. As is well known, it is difficult to construct anything of solid material which can be maintained for prolonged periods at a high temperature without suffering some permanent or subpermanent change in its physical properties, and as we ascend higher in the temperature scale, the difficulties increase in a quite disproportionate degree.

A further aggravation of the trouble is to be found in the chemical activities of furnace products and furnace gases, which, in some cases, render difficult the adequate protection of a resistance-wire or thermo-couple.

With the radiation pyrometers invented by M. Féry, Professor of Physics at the Ecole de Physique et de Chimie, Paris, these difficulties are not encountered, the instruments being, of course, placed at some distance from the furnace, while no part of them is raised above the air temperature by more than 80 Centigrade degrees.

In M. Féry's pyrometers the radiation which emanates from a hot body, or which passes out through an observation hole in the wall of a furnace, falls upon a concave mirror or upon a system of lenses, as the case may be, and is thus brought to a focus. In this focus is a thermo-electric couple, whose temperature is raised by the radiation falling upon it: the hotter the furnace, the greater the rise of temperature of the couple.

The arrangement of the instruments is such that they are uninfluenced, within wide limits, by the size of the hot body or observation hole, on the one hand, or, on the other hand, by the distance which separates them from the hot body or furnace.

The absorption of some small amount of radiant heat in passing through the atmosphere cannot, of course, be strictly without effect; but in practice the error thus arising is not appreciable; it has been found, for example, that the reading obtained for the temperature of a stream of molten steel was precisely the same—1,200 degrees C.—whether the instrument was set up 3 ft. or 60 ft. away.

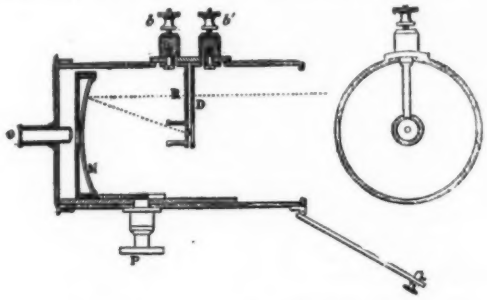

FIG. 1.—THE FÉRY RADIATION PYROMETER; SECTIONAL VIEW.

A complete instrument consists of telescope and galvanometer; fixed within the telescope, at a point upon its optic axis, is the junction of a copper-constantan thermo-couple arranged in the form of a cross. The two wires are attached to two brass strips, D and R, which are attached to the terminals b b^1, Fig. 1. The terminals are connected by leads to the galvanometer, as shown in Fig. 1. To use this apparatus for measuring the temperature of a furnace, an observation hole in the wall of the furnace is sighted through the eye-piece O, the image of this hole being brought into coincidence with the thermo-junction. It is essential that the image of the observation hole should *slightly overlap* the junction, which appears to the eye as a black disc in the centre of the field of view. The readings of the instrument are then independent of the size of the observation hole. In the mirror instrument, the image of the

hole is reflected to the eye-piece O by two small plane mirrors placed close to the couple. These mirrors serve for the adjustment of focus; they are so arranged that the image of the hole appears to be split into two parts, which only blend together to form an unbroken image when the focussing is correct. The image thus formed upon the junction produces a rise of temperature which is shown experimentally to be proportional to the amount of radiant energy which enters the telescope. The junction acquires exactly, and with great rapidity, the temperature of the image, but in no case does its temperature rise by more than 80 Centigrade degrees above the atmospheric temperature. The electro-motive force which is thus generated is measured by a highly sensitive galvanometer whose scale is divided and figured so as to read temperatures directly. The galvanometer has a resistance of about 10 ohms, and is connected by leads about 10 metres (33 ft.) long to the terminals of the pyrometric telescope. The graduation of the galvanometer scale is based upon Stefan's law, which expresses the relation between the temperature of a body and the amount of radiant energy which it emits. The law is as follows:—"The radiant energy emitted by a perfectly black body is proportional to the fourth power of the absolute temperature of the body." This law is a mathematical deduction from the electro-magnetic theory of light.

Though no radiating surface is truly black in the theoretical sense, iron and steel exposed to the air at or above a red heat fulfil this condition very closely, and the same is true of copper, but there is also a much larger class of *effectively black* bodies.

If the inner wall of an enclosure E, Fig. 2, is at one temperature throughout, and if an aperture A through which radiant heat emerges is of small dimensions compared with the depth of the enclosure behind the aperture, then the radiation proceeding from the surface B of the enclosure will be independent of the character of the surface, and the same as if the surface B were perfectly black.

The arrangement sketched in Fig. 2 is one which is actually used in taking furnace temperatures by means of the Féry pyrometer.

Moreover, in many industrial processes, a knowledge of actual temperatures—Centigrade or Fahrenheit—is not essential, provided some standard is available which serves to distinguish between higher and lower temperatures, and enables correct heat conditions, once obtained, to be reproduced with certainty. Suppose, for example, that we are sighting the pyrometer on the metal in a crucible, and that the reading obtained on the temperature scale of the galvanometer is

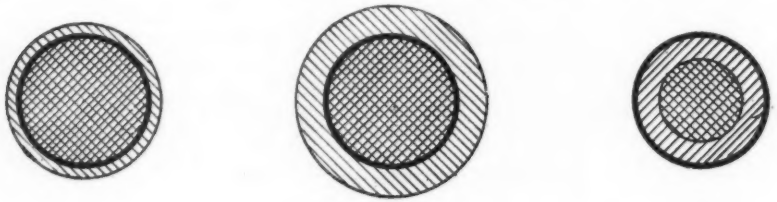

FIG. 3.

1,100 degrees C. Owing to the surface of the metal not being absolutely black this reading may be lower than the true temperature, which we will suppose is 1,180 degrees C. If we find that the castings obtained by pouring the metal under these heat conditions are satisfactory, and better than those resulting from pouring either hotter or colder metal, we shall have reached the important practical conclusion that the correct pouring temperature for the metal in question produces a reading of 1,100 degrees C. on the temperature scale of the galvanometer, even though we do not know the true temperature of the metal on the Centigrade scale.

Since the energy radiated from a hot body increases very rapidly as the temperature is raised, it follows that the Féry pyrometer is far more sensitive at high than at low temperatures. Temperatures as low as 600 degrees C. can be read, but the instrument is most useful for high temperature work. As examples

of high temperature measurements made with the Féry pyrometer, we may mention the temperature of the sun (7,800 degrees C.) determined by Professor Féry, as well as the temperature of the iron in a thermit mould, which was found to be 2,500 degrees C. The instrument is thus of especial value for taking such high temperatures as those of molten steel, of gas settings, of glass furnaces, brick kilns, and electric furnaces. Its great flexibility, and the readiness with which it is sighted, enable it to be used for taking the temperature of metal in a crucible just before pouring, thus ensuring correct casting temperatures, a point which is now known to be of especial importance in the case of steel castings.

A point which may need further ex-

FIG. 2.—ARRANGEMENT FOR TAKING FURNACE TEMPERATURES BY FÉRY PYROMETER.

planation is the arrangement which ensures that, within limits, the readings of temperature shall be independent of distance.

Suppose that we are sighting the telescope upon a hot body of limited dimensions. The total amount of radiation reaching the aperture of the lens or mirror will vary with the distance from the hot body, and will be inversely proportional to the square of the distance. If, then, the receptive surface of the thermo-junction were sufficiently extended to receive the whole of the radiation which is converged to a focus by the lens or mirror, we might expect the indications of the galvanometer to fall off as the distance was increased. The thermo-junction, however, is not large enough to receive the whole of the radiation which converges towards it. The real image of the source, formed by the lens or mirror, overlaps the thermo-junction on all sides (Fig. 3*a*), so that when we approach the source more nearly, thus increasing the size of the image produced, the only effect is to increase the amount of overlapping, while the thermo-junction receives no more radiation than before (Fig. 3*b*). On the other hand, if we withdraw to so great a distance that the image formed is too small to cover the thermo-junction completely (Fig. 3*c*), the readings obtained will be too low, and will become lower and lower as we recede further and further from the source of heat.

From the above it will also be readily understood that when we are working at any given distance from the hot body, it is necessary for the body in question to be of sufficient size, otherwise the image of the body would be too small to overlap the thermo-junction on all sides. But provided the hot body is large enough to secure the necessary overlapping, no further increase in its dimensions will add to the amount of radiation actually received by the thermo-junction. The diameter of the hot body (or furnace aperture) should measure as many inches as the distance from hot body to pyrometer measures yards.

A similar galvanometer is also made and calibrated so as to measure directly low temperatures, the temperature of liquefaction of gases, liquid air, and liquid carbonic acid, or for the measurement of moderate temperatures between 0 degrees and 600 degrees C. In such cases the galvanometer is connected by leads to a copper-constantan thermo-couple immersed in the medium whose temperature is required. The couple is enclosed in a tube which leaves the junction exposed. These couples should never be heated above 700 degrees C.

The sole agents for the sale of this instrument in Great Britain and her Colonies, America, Norway and Sweden, are the Cambridge Scientific Instrument Company, Limited, Carlyle Road, Cambridge.

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THOMAS PIGGOTT & COMPANY, LIMITED, of Spring Hill, Birmingham, have secured orders for 20 pressed steel standard tanks; a rivetted steel chimney, 6 ft. diameter by 125 ft. high; pressed culvert pipes, 36 in. diameter; and rivetted rectangular flues.

REPAIRING A STERN POST.

Mr. E. Stutz, in a lecture before the Franklin Institute, gives an interesting description of the mending of a stern post casting by thermit. The repair was made on the Clyde Line steamer "Apache," of 4,100 tons. The "Apache" was placed in dry dock about 1 p.m. on July 28, 1905. The dock was a graving dock, and the water was entirely pumped out at 2.15 p.m. Propeller wheel was removed and shaft drawn in to the hull, for the purpose of examining same for the benefit of underwriters. It was not necessary to remove the wheel and shaft to perform the work. The shoe or skeg had been patched. Two large plates had been placed—one on each side—and top and bottom plates had also been put on, forming a box, as it were, around the break. These were removed at 3.20 p.m. The break was found to be about 18½ in. from the after side of what is termed the "stern post" (not the rudder post).

A mould and mould box had been previously prepared. Allowances were made in the clay mould, so that it could be fitted tightly to the skeg. It was decided to have an aperture or clearance in the break, for the metal to flow through, and as it was impossible to spread the broken parts, a series of holes 1 in. diameter were drilled vertically through the skeg—nine in number—following the line of the crack. The section to be welded measured 6¾ in. vertically by 11 in. horizontally. The men with air drills were started to drill these holes as soon as the patches were removed, and as this work would take them long into the night, after darkness set in, nothing further was done on the work the first day.

Next morning the skeg was heated to a red heat and mould box taken from the furnace and put in place. A foundation was built under the mould box, and a riser of brick, forming a base with a wall about one brick wide and about 12 in. high, was formed around the mould box, forming a basin, into which moist sand was poured. The joints were well luted and sand well packed up around the luting, so that the entire mould was thoroughly protected in case of any leaks. The mould had been so arranged, as the section to be welded was very broad (11 in.) it was thought best to have it well ventilated, and five risers were prepared, the riser box being very shallow, with a spout for the slag to run off, and a trough in the sand leading to a pit which was formed at one side.

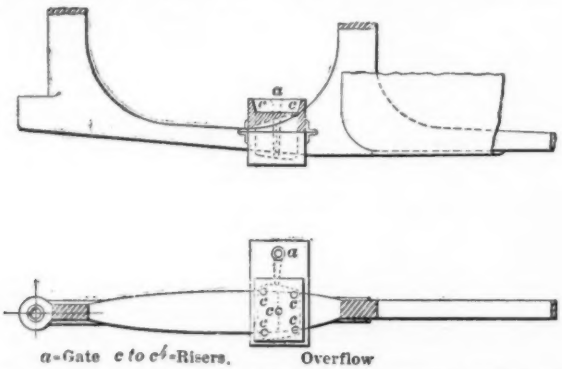


Fig. 1.—Mould and Mould Box used in welding operation, Steamship "Apache."

A small open furnace had been prepared and placed on top of the mould, in which a charcoal fire was burnt. Air from the compressed air supply on the dock was utilised for draught, and hot gas was forced down through the gate and up through the riser. While this was in progress the crucible was put in place, the ordinary tripod being used. There were placed into the crucible 475 lbs. of thermit, together with 100 lbs. of steel punchings—the punchings and the crucible having previously been heated. The mixture of the thermit, punchings, and manganese was performed by pouring in each consecutively, each being well stirred as it was placed into the crucible.

Owing to the pre-heating, the final reaction was retarded until 4.35 p.m., when the thermit was ignited and the reaction took place. Thermit was then used in feeding to the risers and gate, feeding in gradually, maintaining continuous reaction for several minutes, to relieve the mould of gases which might form in the body of the weld. This proved to be very effective, as much gas was seen to come from the mould through the riser and gate during the feeding process. This was continued until 50 lbs. of thermit had been consumed.

The mould was allowed to remain in place over night, gradually cooling, and was then annealed by surrounding the weld with a box, in which a charcoal fire was prepared. This fire was continued about five or six hours, allowing the weld to cool gradually. In the morning, when the mould boxes were removed, the gate

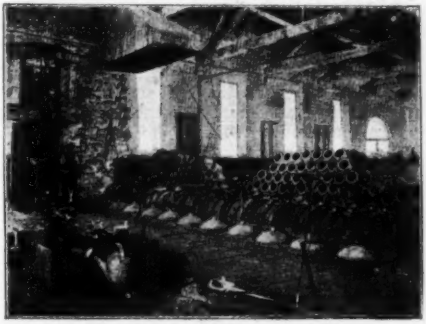
PNEUMATIC MOULDING MACHINES.

and risers were trimmed off, and the grain of the metal appeared to be of exceptionally good quality, and cut very freely with the air tools. The shaft and propeller wheel were then put in place, and the vessel was ready for docking at 10 a.m. of the third day.

An improved method of making such steamship shaft welds has lately been developed at Essen. The mould is placed in position after the fracture has been opened out and cleaned, but before it is heated. A suitable coke stove is then placed over the mould, and connected with it is a blower, which drives the fire gases through the coke, around the piece to be welded, and brings not only the latter, but also the mould, to a high degree of temperature, thus facilitating the weld and eliminating all possibility of moisture in the mould. This process has been found particularly valuable for the repair of pieces of great diameter.

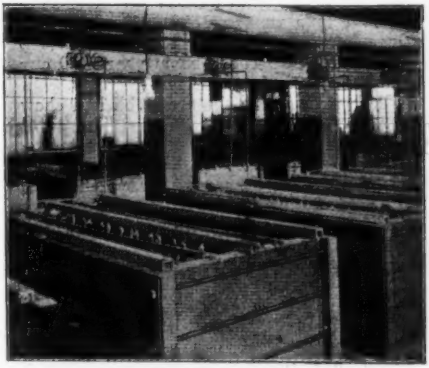
A TYPEWRITER WORKS FOUNDRY.

THE annexed illustrations are of interest as showing three views of the works in which the Remington Typewriter is made.



A CORNER OF THE BRASS FOUNDRY.

All the castings required are made in the company's foundries. The brass foundry, with 14 melting furnaces, furnishes the various bronzes and alloys of copper, zinc, aluminium, and nickel, which are necessary for the lighter but severely-handled typewriter parts. The castings, whether of bronze or cast-iron, are produced entirely by the use of 23 Tabor pneumatic mouldings, hand moulding having been completely superseded by the cheaper, cleaner, quicker, and more accurate machine process with very finely-



THE PLATING TANKS.

adjusted metal patterns. The castings of various metals after pickling, tumbling, and inspection are started on a systematic journey of the shortest possible length and

with minimum handling, along with stamping, screws, and automatic machine products.

In the case of the removal of material without regard to exact gauging, belt-grinding supplies a cheap and satisfactory method of getting into and round the corners of pieces; while the drilling of one hundred holes at once in the top plates by special automatic drilling machines in three and a-half minutes, one man only being required to attend to each three machines, is perhaps the acme of labour-saving in this direction.

Each of the various distinct parts, after being drop-forged, machined accurately to gauge in costly fixtures, ground, polished, annealed, plated, buffed, japanned, assembled, compounded, and finally inspected, is stored in a well-oiled condition on perpetual inventory in the cabinets of the finished parts stock room. The works occupy 6½ acres, and are built to employ 2,000 men.

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THE BRITISH PIG-IRON OUTPUT OF 1905.

THE total output of pig-iron in 1905 was 9,592,737 tons, which is an increase of 1,030,079 tons on the output of the previous twelve months. This is the greatest advance made in any one year for a considerable period. The output of 1905 is, moreover, the greatest in the history of the trade. The last time that our annual pig-iron output exceeded nine million tons was in 1899, when the production was 9,305,319 tons, or 287,418 tons less, while in the boom year 1900 our output was under nine million tons.

The statistics which are published show another gratifying feature. The total average number of furnaces in blast during the year was 346, which compares with 325 in the previous year, so that our additional output of over a million tons has been secured with only 21 more furnaces in blast. This means that in 1905 the average output of pig-iron per furnace in blast throughout the country was 27,654 tons, against 26,346 tons in 1904. No one can fail to see in this fact an evidence of the gradual improvement which has now been going on for a number of years in our blast furnace practice. Much remains to be done in this direction, especially in the Midlands.

At the present time the average rate of production is materially greater than it was in 1905. The number of furnaces in blast at the end of the year, as ascertained and published in the "IRON AND COAL TRADES REVIEW" of January 19, was 359, or 13 more than the average in blast during 1905. If the average annual output of these furnaces be taken at 27,000 tons, we should be producing at the present time at the rate of close on ten million tons of pig-iron per annum, a figure which considerably exceeds that of any previous period in the history of the trade.

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As an illustration of how the natural fracture of an iron can be changed, if soft iron, high in silicon, when it is liquid, is poured into cold water, it at once becomes white, whilst white iron, when liquid, if poured into a massive casting and allowed to cool slowly, the centre of the casting will be somewhat grey, thus showing that silicon is not absolutely the means by which combined carbon is converted into graphite, although it is a simple and ready means whereby the ironfounder can generally judge his grades of iron.

PERHAPS the reason why the Americans can work so well on analyses is that there is probably not an ironfoundry of any consequence which has not a metallurgist or metallurgical engineer, whose duty it is to attend solely to mixings, and accept or reject pig-irons as they are delivered. Where one foundry is not large enough to employ one man exclusively, several group together and pay a retaining fee, and as this practice is increasing in favour it seemingly must be found to pay. This metallurgist is not necessarily a chemist, and a chemist is not always a metallurgist, but when the two can be combined in one man, so much the better.

IT would be dangerous to lay down any rules for guidance as to the mechanical condition of pig, as, when given tests are required this alone is not sufficient to form a judgment, and both the mechanical and chemical conditions must be considered together. The mechanically strong pig usually shows a good "pull" on the surface of the fracture, but the form which this "pull" takes, varies considerably in each grade of iron, and whilst some founders lay great stress upon the difficulty in breaking a pig, the writer has had cases under his personal notice where this has been no guide whatever—the difficulty or otherwise of breaking pigs being sometimes dependent on methods of cooling and size and length of pigs.

PRIDMORE MOULDING MACHINERY.

Mr. J. A. Brodin has patented a device which is here illustrated as applied to a Pridmore moulding machine. Fig. 1 is a plan view of the moulding machine with the pattern in place. Fig. 2 is an inverted plan view of the pattern carrier and the pattern. Fig. 3 is a vertical section on the line *a*—*a* of Fig. 1. Fig. 4 is a vertical section on the same line with the parts in another position, showing the pattern ready to be lowered after the mould has been made.

The stripping plate carrying the flask is secured to it by the pin A at one side. This projects upward from the stripping plate and passes through a hole in the rim of the flask. At the other side the parts are held by the pin B extending through another lug. A rectangular frame C is braced underneath by horizontal arms and carries the pattern, the combination resting on a vertical support moving freely in the main frame of the machine to allow the pattern to be raised and lowered through openings in the stripping plate. The pattern is secured to the carrier C by bolts and has two movable hook-shaped parts D turned in opposite directions. The latter gives the desired contour to the mould at these places. The projecting parts D are suitably linked to a bent bar E having a hub at the centre embracing the shaft F to which it is firmly secured. The shaft F has stop lugs adjusted with setscrews to limit the rotary movement in either direction. The shaft also has a crank and handle. Upon the crank rests the grooved end of the latch G.

This form of the machine is particularly adapted for making the upper portion of colds for casting interlocking brake-shoes, and especially the peculiar opening in the mould for forming the hooks on the castings. The purpose of the contrivance is toward mould making which in the case mentioned will obviate the necessity of coring, a part of the pattern being first withdrawn, then the pattern as a whole is freely separated from the mould.

The projecting parts D are first set by turning the crank handle until the convex faces of the links rest on the angle irons, the rotation of the main shaft being arrested at this instant by one of the stop lugs contacting with its setscrew. The latch G, the grooved end following the crank, prevents the projecting parts D from being forced back by the impact of the sand in the process of making the mould. When this process is completed, the latch G is lifted and the hand crank turned in the opposite direction, withdrawing the hooks D far enough to allow the pattern to be lowered without injury to the mould. The backward turn is arrested at the proper point by the contact of the other stop lug with its setscrew.

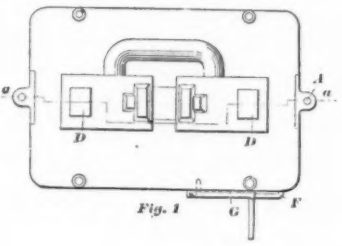

Fig. 1

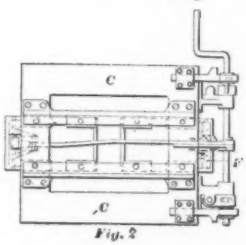

Fig. 2

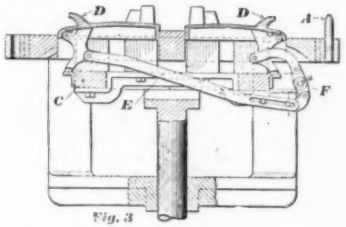

Fig. 3

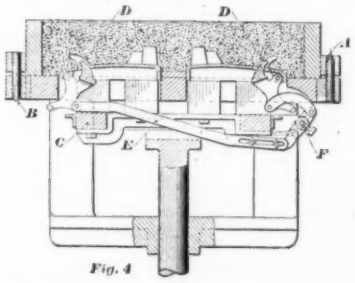

Fig. 4

CASTING BRASS CHAINS IN INDIA.

Mr. J. H. Girling writes:—Some time ago I was much interested in reading an account of iron smelting in West Africa in your Journal. I enclose an account of a method of casting brass chains in India, taken from the "Proceedings" of the Iron and Steel Institute some twenty years ago. The paper was written by Sir C. Purdon Clarke, and is as follows:—

The peculiar anklet known as *santh*, made up of flat links formed at one casting, is produced in Southern Rajputana and Central India, and especially at Sawia Madhopore, a Jeypore town beneath the famous fort of Ranthambhor, which stands in the hills near the junction of the Banas and Chambal rivers. Here twenty-five men obtain a livelihood in making these ornaments. Their ancestors brought the art from Bundi a hundred years ago. The anklet is termed *sant* or *santh*, from Hindu words signifying joining or sticking.

Fig. 1.—Melting and Preparing the Wax.

A.—Vessel in which wax and ral are melted.
B.—Vessel containing cold water into which mixture is dropped.

Three different varieties of the *santh* are made at Sawia Madhopore:—

1. *Sut wan santh*, in which the pattern is of plain or thread-like links.

2. *Chakti dar santh*, having small patches or projections upon its edge.

3. *Kil kunda-ki santh*, which is fastened by a screw.

The following is a description of the process of manufacturing a plain *santh*, variety 1. Several specimens were made in the writer's presence.

A composition is prepared of seven parts of wax, forty parts of resin or *ral*, eleven parts of oil sesame. These ingredients are well mixed and melted together in an earthen pot. The mixture is then poured through a fine cloth into another vessel which is nearly full of cold water. It falls to the bottom in a thick mass, which is then pulled and re-pulled in the fashion of making barley sugar, and again dropped into cold water. A portion of it is next taken and rolled out with a flat wooden tool on a board, in such a way as to form from one end of the cylinder a long thin string of the thickness of the future links of the *santh*. A stick, having the same diameter as the proposed links, is taken, and the thin wax cord is coiled round it from near one end to the other. A straight cut is next made along one edge of the spiral, by which a number of rings open at one side is formed. A knife edge is made hot in a charcoal fire, and by applying the ends of the rings to it they can be easily united. One ring is first formed, and then the second linked into it; the two edges of the third ring are passed over the first two and joined. The fourth ring, in like manner, passes through the two preceding it, and thus the process is continued until perhaps sixty or seventy rings are used, a sufficient number to make an ordinary anklet. When a curbed chain of the requisite length has been thus formed, it is flattened out on a board and the ends united. The workman takes the anklet in his hands and rapidly moves it through his fingers, and presses the links together in such a way as to make the ornament firm, flat, and regular. He uses warm or cold water as may be necessary to insure that the wax maintains a suitable pliancy.

Fig. 2.—Rolling out the Wax Cylinder to form thin Wax Rod.

A solution of red clay is prepared in the following manner:—Red clay three parts,

dried cowdung one part, with sufficient water. The first two ingredients are powdered and made into a paste with water. The wax *santh* is dipped in the composition, so that the fine clay adheres to every part of the links. As soon as the coat becomes dry the operation is repeated, in all four or five times.

A thicker paste, composed of red clay (not strained) sixteen parts, fresh cowdung two parts, water one part, is spread over the *santh* so as to form a mould. Three coatings are required. When the mould is dry the upper edge is scratched with an iron tool so as to expose the wax links within. The links are oiled, and a flat thin piece of wax is attached to them all along the edge by means of a hot wire.

FIG. 3.—WINDING THIN WAX ROD INTO A COIL ROUND WOODEN STICK.

All the inequalities are removed by careful scratching, and the whole covered with the clay paste, which is allowed to dry as before. A quarter of an inch of the top of the *santh* is left uncovered by the clay, and to the portion of the wax thus exposed is attached a thicker ribbon of the same material an inch long, a quarter of an inch broad, and one-sixth of an inch thick. The top band, the ribbon, and the links are thus continuous, though the latter are quite separate from each other.

Two *sanths* are cast together, and for this purpose are so placed that the leading rods on each anklet are next each other; the two red ribbons are close together at the top.

Three distinct coatings of the thick paste of red clay are now applied over the pair of *sanths* so as to form one ring-like mould, which ends in a boss or projection over the end ribbons.

To prevent cracking of the moulds and loss of metal, a coating of thick black earth mixed with chaff in the proportion of thirty-two parts of the former to one of the latter is applied over the whole mould, and the top over the projection containing the ribbons is formed into a cup. The mould is now ready for casting.

The metal usually employed is a comparition termed *dharkree*, *phut*, of *bharat* by the workmen; *kansi* or bell-metal by the public. It is composed of sixteen parts of brass and six of zinc. Another mixture is made of sixteen parts of the above mass with four additional parts of zinc. A third consists of old and broken anklets.

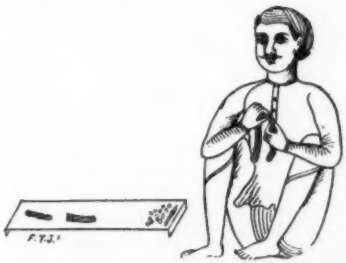

FIG. 4.—FLATTENING OUT THE RINGS OF THE WAX MODELS.

The melting is done in a small conical cup termed *mus*, which is made of black potter's earth. A sufficiency of metal is taken and placed in pieces in the *mus* with a small quantity of borax. (For a *santh* of one seer, one and a quarter seers must be used to admit of wastage.)

The *mus* thus filled is inverted over the top of the cup-shaped head of the mould in which the way ends of the ribbons have been exposed, and the edges of the two are united by the black earth and chaff composition. A small opening is also made in the mould near the top by means of a style to allow of the escape of the wax.

The kiln is simply an open furnace, or pit in the ground, filled up with dried cowdung cakes. The moulds are placed in this and made red hot. After a time the wax escapes in black fumes, and the metal melts. When the metal is quite melted blue fumes appear. The moulds have been kept upright, the inverted *mus* being at the bottom. They are removed

in this position, and cracks from which fumes escape are carefully plastered over with clay, and the whole dipped for an instant in cold water. The mould is now inverted, and the melted metal pours into the cavity from which the wax has been burnt out. All that remains is to take out the ornament when the mould is cool, to break off the leading rods and ribbons, and to file away any inequalities or adhesions which may prevent free movement of the links.

A *santh* made of *dharkree* is of a yellow colour. If of equal parts of the above and of old anklets it will be white. The latter variety only is made at Sawai Madhopore.

FIG. 5.—FORMING THE MOULD FROM CLAY.

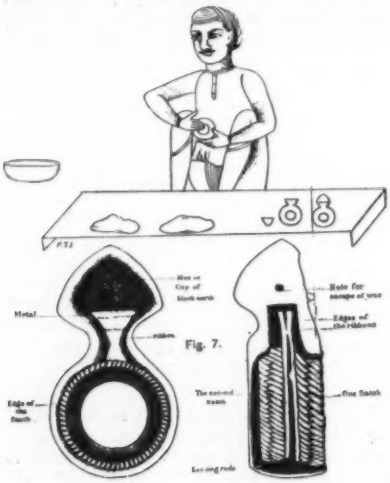

FIG. 7.

MOULD CUT OPEN ON ONE SIDE AFTER THE ANKLETS ARE CAST.

MOULD CUT OPEN ON THE EDGE TO SHOW PAIR OF SANTHS.

When the *santh* is finished it may be plated with a composition of pewter or *rang*, forty parts; hydrochlorate of ammonium or *nausadar*, one part. The pewter is made of three parts of zinc and two of lead.

A small portion of the composition is applied to each *santh* by heat, and the anklet is then cleaned and brushed with cold water.

One man can make twenty-five pairs of *sanths* in fifteen days at a cost of five rupees for fuel and labour, and five rupees for metal. He does nothing else, and sells the ornaments himself at from eight to ten annas a pair.

He requires about one and a half maunds of charcoal to make twenty-five pairs of *sanths*.

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BLOW-HOLES OR AIR CHAMBERS IN IRON CASTINGS.

By R. F. W.

PROCESSES for the prevention or the filling up of blow-holes in castings are frequently advertised, generally taking the form of a cement or mixture which, when added to the ladle of metal, are claimed to act upon it for the desired result. Blow-holes are a source of con-

FIG. 6.—PILE OF BURNING COWDUNG CABRES IN WHICH THE MOULDS ARE HEATED

siderable trouble, anxiety, and waste of time to moulder, fitter, turner, and master alike. It is annoying after having proceeded with a casting as far as the marking off to find, on machining it, that the presence of blow-holes makes it useless. Let us, then, consider, under their respective headings, the various causes of blow-holes in castings. First, the true blow-hole, caused by defective coring; second, air chambers occurring with poorly melted metal; and third, the cavities resulting from improperly mixed metal. The first arises from the carelessness or ignorance of the moulder or the coremaker. Even when a core is properly made, moulders are occasionally indifferent as to sufficient provision being made for the escape of the gases, and explosions occur which ruin the casting. The sand used for cores has a foundation

of the ordinary red sand used for facing, to which is added more porous material. The ordinary red sand contains clay and marl in quantities variable according to the district or the particular strata from which it is obtained. While the presence of these substances in the sand ensures the necessary toughness and cohesion, when rammed up, the flakes of marl or clay produce partitions in the core, and prevent a free escape of the gases into the vent. The gases under the hot metal expand, and if free escape is not permitted from the outer edges of the core to the vent, the pressure will sweat through the skin of the core and prevent the molten metal from lying close and solid round it; and this sometimes without giving any signs of heaving when being poured. It is necessary that a core should be sufficiently porous to allow the free escape of gases, and yet be strong enough to withstand the pressure brought to bear upon it in the mould. The core-maker, as well as the moulder, should see the pattern in order that he may have a clear idea of what is required, and the conditions under which it will be used, and so work accordingly.

Respecting the second cause under consideration, it is essential that the metal be run from the cupola in a thoroughly hot and fluid condition; though it need not necessarily be poured at the same temperature, this being left to the judgment of the moulder. A common error in foundry practice is to consider that thick castings do not require a very fluid metal; but experience has proved that metal run from the furnace, while only at a dull colour, does not produce a casting suitable for machinery parts, or one sound enough for machining. The cupola must be worked systematically, and any attempt to force its capacity will end in failure. The melting capacity of the furnace must first be ascertained, as a charge which is too light involves a waste of coke and time, while at the same time no amount of extra coke will assist a load which is too heavy. As example, a furnace with a melting capacity of 4 tons per hour, carrying a load of 28 cwts. per charge, and requiring about 2½ cwts. of coke to melt successfully, will not give a corresponding increase in result with a 38 cwts. charge, and a proportionate addition of coke. When the charge has settled down to the melting zone there will not be sufficient coke left to melt it, with the result that pieces of pig will appear round the tuyeres. The metal will heat successfully at the first part of the charge, but will gradually get worse towards the finish. Poor coke, also, has a bad effect, excessive sulphur combining with the iron and causing it to run down at a lower temperature. Such metal is covered with a scum, and it is impossible to obtain from it clean, sound castings.

Let us now consider the third cause, which produces draw-holes or spongy castings. Some considerable care is required in the mixing of various grades of pig-iron in order to obtain a tough, yet fairly homogeneous casting, for when the metal is melted an excess of graphite causes a tendency to "draw" or shrink. The metal is not able to absorb or to combine with the excess of carbon which, therefore, rises to the top, separating in the form of bright flakes or powder. The gases which it has taken up in the mould combine with it, causing small air chambers, which at first sight look like blow-holes.

In the present age of progress it is only proper for us to diverge from the crude methods of former times, and call to our aid the knowledge revealed by modern science, for only by so doing can a cheap and rapid process be attained.

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QUERIES.

CASTING REPAIR PARTS.—Please say if it is legal to make castings for repair work to such things as parts for patent agricultural machines, ranges, gas engines, etc. Also, if anyone brought in a pattern off a patent, who would be held responsible, the giver of the order or the person who fulfils it?—"B."

PATCHING UP FURNACES.—Is ganister much superior and more economical than fireclay for patching up furnaces?—"NOVICE."

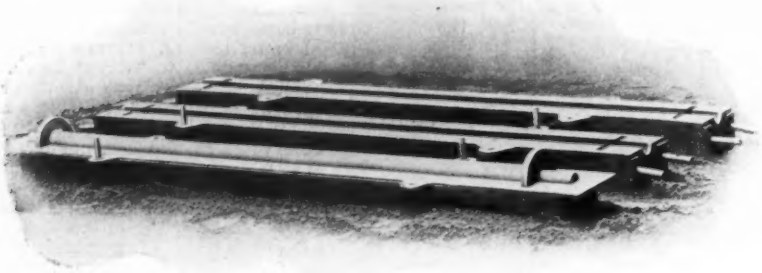
DEFECTIVE CASTINGS.—We have for some considerable time past been troubled with defective castings, similar to the enclosed, which is part of the rim of a pulley, and the bottom edge of it. As it gets nearer to the top of moulds the castings are worse. We do not mean to say that all our castings turn out like this; but this is one of the worst we have ever had, and thinking, perhaps, you could assist us in solving the mystery, we take the liberty of sending you this piece of metal, and shall be glad to hear any suggestions from your readers.—"W."

CRUCIBLE MIXTURES.—Can any readers of your valuable paper give me a good mixture for making crucibles suitable for melting gun metal?—"J. E. B."

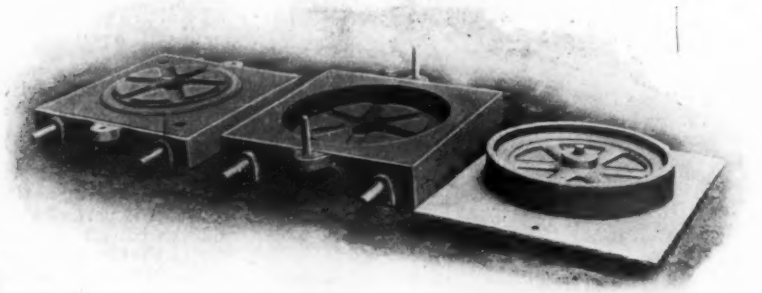
"MITO" METAL.

"MITO" METAL, which is being put on the market by the Mito Metal Company, of Phœnix Works, Wakefield, is an alloy specially intended for foundry pattern work, for which use some exceptional features are claimed. The outstanding advantages of the alloy are its lightness and strength, these qualities being so prominent that plate work in the foundry can be extended to much heavier castings than would be possible in ordinary practice. "Mito" metal is stated to be less than half the weight of iron or brass, and it will withstand a breaking strain of 12 tons per square inch ; it does not bend or get out of shape, has a clear smooth surface, and does not rust; it is easily machined, and can be worked by the fitter more quickly and cheaply than iron or brass.

It is claimed that a saving of 50 per cent. can be attained in the foundry by making use of this alloy, a man being able to do double the work with a "Mito" metal pattern plate. Further, the cost of moulding machines, with the expense of upkeep, can be done away with in most cases, and an increased economical output produced. All loose and delicate parts of any patterns subject to damage in the foundry, all small standard patterns, are, it is urged, with advantage made of "Mito" metal, as it does not warp or rust or absorb moisture or clog if left in the sand; whereas patterns made from either iron or wood are subject to all these drawbacks. It is also economical to use "Mito" metal for pipe templates, gauges, small brackets, etc., which are in daily use in every foundry.



"MITO" METAL.



"MITO" METAL.

We are informed that "Mito" metal plates worked on the snap flask principle

have proved most satisfactory and have shown large savings on repetition work. As an example, it may be mentioned that at one establishment up to two years ago six machines were being used to produce a repetition casting, with fourteen men to work them, whereas now an increased output at a much reduced cost is being secured at the present time by nine men using snap flask moulding frames and "Mito" metal plates. The machines, it is stated, have since been scrapped, and the makers of "Mito" metal contend that it would pay engineers to serve their cast iron and brass pattern plates in the same way, and substitute "Mito" metal.

It may be added that the melting point of "Mito" metal is rather less than brass, otherwise it is treated in a similar manner.

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THE TEMPERING OF BRONZE.

Some interesting experiments have recently been made as to the effect of tempering upon bronzes. It is known that some kinds of bronze are softened by tempering. On the other hand, M. Riche showed that bronzes which contain a considerable proportion of tin, 15 to 20 per cent., are malleable when hot, while they are brittle when cold. The experimenter wished to find the influence of tempering upon the mechanical properties, using different specimens of metal. To carry this out he submitted bronzes from 5 to 21 per cent. of tin to a tempering which varied in different cases from 300 to 800 degrees C. He draws the following conclusions from these tests:—1. Alloys containing more than 92 per cent. copper have their breaking strain increased somewhat by tempering at a low temperature between 400 and 600 degrees. The elongation varies in about the same way. 2. For metals containing less than 92 per cent. copper, the breaking strain and elongation increase in marked degree when the temperature of the tempering exceeds 500 degrees. The maximum breaking strain is reached for all the specimens for a tempering carried out at about 600 degrees. On the contrary, the maximum of the elongation seems to vary with the composition of the alloy. It occurs at a tempering of 800 degrees for the bronze containing 81 per cent. copper and 19 tin, and at 600 degrees for 79 copper and 21 tin. The difference between the breaking strain of the non-tempered cast metal and the pieces which are tempered at the most favourable temperature is greater according as the proportion of copper is smaller. In general, it is to be concluded that the tempering of bronze between 600 and 800 degrees C. brings about much better results as to traction tests. As to the resistance to friction, the effect is to be studied in the further experiments.

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THE FOUNDRY INDUSTRY OF GERMANY.

The foundry industry of Germany has made great progress recently. The total output of iron castings produced in 1904 was 2,363,674 tons, against 1,721,781 tons in the previous year, while the number of foundries had been raised from 1,302 to 1,621, or an increase of 319. The number of workmen employed at foundries increased from 87,821 in 1903 to 104,804 in 1902, or a total advance of 16,783. It may here be noted that the increase in the number of steel works in the same interval was only one, while 8,523 was the increase in the number of hands employed, showing that the foundry industry has been increasing much more rapidly than that of steel making. The quantity of pig-iron consumed in German foundries in 1904 was not fully ascertained, because of the omission of a number of works to make returns, but the quantity of foundry pig produced in Germany in that year was 1,740,279. The average value per ton of the foundry castings produced in 1904 was 169.46s., against 164.79s. in the previous year.

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The Brooke Tool Manufacturing Company, Limited, of Birmingham, have appointed Mr. A. E. Morrice, 17, Billiter Buildings, Billiter Street, London, E.C., as their London export representative.

Cold Blast and Refined Pig-irons.—In simple language it is not easy to explain the difference between hot and cold-blast irons. The mechanical condition of cold-blast and refined irons no doubt is the difference between these and the average hot-blast irons. This comes under methods of manufacture, and the thermal conditions under which cold-blast and special irons are made tend to produce in these irons a smaller molecular structure, hence their grading must necessarily be somewhat different, as, generally speaking, these irons have a lower silicon content, number for number. For instance, a No. 1 cold-blast will be much closer than a No. 1 hot-blast, as will also Nos. 2, 3, 4 and 5.

TRADE TALK.

Messrs. Wm. Samson & Company have removed to 88, Great Clyde Street, Glasgow.

The Crane Company have closed their offices at 95, Queen Victoria Street, London, E.C.

Mr. A. Sharp, consulting engineer, has removed to Thanet House, 231, Strand, London, W.C.

Messrs. H. Robinson and C. Proctor, engineers, Manchester, have dissolved partnership.

New plant is being put down by the Sheffield Forge and Rolling Mill Company, Limited.

Negotiations are steadily progressing for the formation of a National Iron Trade Association.

Messrs. Jenkins Brothers have removed into new premises, at 95, Queen Victoria Street, London, E.C.

The London business of the Delta Metal Company, Limited, has been transferred to new works at East Greenwich.

The Coalbrookdale Company, Limited, have established new showrooms at West India House, Welsh Back, Bristol.

Thwaites Brothers, Limited, of Bradford, have opened an office in West India House, Leadenhall Street, London, E.C.

Norman, McKie & Company, Limited, has been formed to carry on the business of engineers, etc. The capital is £500.

Hay's Foreign Patents, Limited (capital, £5,000), has been registered to carry on the business of engineers, etc.

Messrs. R. & F. W. Wright, engineers, etc., trading as R. Wright & Son, Sudbury, Suffolk, have been adjudged bankrupt.

Samuel Fox & Company, Limited, Stocksbridge, Sheffield, contemplate extensive improvements to their already large plant.

Messrs. A. A. Such and S. H. Mountain, engineers, etc., Cheltenham, trading as Such & Mountain, have dissolved partnership.

A dissolution of partnership is notified in connection with Messrs. C. Drakard and F. Drakard, engineers, etc., Boston, Lincolnshire.

The Lowca Engineering Company, Limited, Whitehaven, have established an office at 5, Laurence Pountney Hill, London, E.C.

It is stated that a firm of engineers have decided to establish new works at Lutterworth, on a site adjoining the Great Central Railway.

Mr. W. W. Buckton and Mr. H. J. Jones have entered into partnership as consulting engineers, and have taken offices at 72, Victoria Street.

Messrs. Everitt & Company, Chapel Street, Liverpool, have been appointed Liverpool and district agents for the sale of the Britannia oil-engine.

Messrs. J. Williams & Sons have started business at Smithfield Road, Aberystwyth, having secured the Central Foundry and Engineering Works.

A dissolution of partnership is notified in connection with Messrs. W. J. Eke and J. Wilders, iron and brass founders, etc., Milton-next-Gravesend, Kent.

A fire occurred during the month at the premises of Messrs. Bathgate & Company, engineers, at 61, Albert Street, Edinburgh. The damage was not serious.

Messrs. Cammell Laird & Company, of Sheffield, have denied the report that they are endeavouring to acquire land at Port Talbot on which to erect new works.

The North-Eastern Steel Company, Limited, have removed their London establishment from 97, Cannon Street, E.C., to 31, Budge Row, Cannon Street, E.C.

Price, Edwin & Company, Limited, has acquired the foundry and engineering works at Neath, Glamorgan, lately carried on by Price's Engineering Company, Limited.

Foundries, Limited, has been formed to take over the business carried on by the North London Engineering Company, Limited. The capital is £1,500 in £1 shares.

Hercules Engineering Company, Limited, has been formed to acquire the business lately carried on by the Queen's Engineering Works, Limited, at Holbeck, Leeds.

Messrs. G. R. Mather, C. J. Mather, and R. W. Randall, engineers, etc., Wellingborough, Northamptonshire, have dissolved partnership, so far as regards Mr. W. Randall.

Tweedales & Smalley, Limited, has been registered with a capital of £210,000 in £10 shares, to carry on the business of engineers, etc. The registered office is at Castleton, Lancs.

Samuel Birkett & Sons, Limited, has been registered with a capital of £5,000

in £1 shares, to acquire the business carried on by Samuel Birkett & Sons, brass and ironfounders, Cleckheaton.

Messrs. Kirby, Son & Brown, Stow Chambers, Newport, Mon., have associated themselves with Mr. G. J. Hooghwinkel, consulting electrical engineer, of Dacre House, Westminster, S.W.

The Malleable Steel Castings Company (1906), Limited, is the name of a concern formed to take over the business carried on by the Malleable Steel Castings Company, Limited, at Pendleton.

The Norton Harty Engineering Company, of Tipton, Staffs., have appointed Mr. C. Pearson, Southend Avenue, Darlington, as their representative for Northumberland, Durham, and Yorkshire.

Mr. W. Darling, 76, Queen Street, Cheapside, E.C., has been appointed to jointly represent the ironfoundry department of Wilsons & Mathiesons, Limited, Leeds, and the London Scottish Foundry, Limited, Barking, Essex.

The Stirling Boiler Company, Limited, of Motherwell, are supplying the boiler plant in connection with the large extension at the Parkhead Forge Works of Messrs. William Beardmore & Company, Limited, Glasgow.

Manchester people have voted against the proposed construction of a tramway by Sir W. G. Armstrong, Whitworth & Company, Limited, between their present works and new works on the other side of the highway at Openshaw.

At the Manchester Works, Openshaw, of Sir W. G. Armstrong, Whitworth & Company, Limited, what is considered the largest steel ingot that has ever been made was cast on February 1, the ingot weighing no less than 120 tons.

T. S. Forster & Sons, Limited, is the name of a company formed with a capital of £10,000, to acquire the business carried on by T. S. Forster, at Copperas Bank Forge, Sunderland, and to carry on the business of iron, steel, and brassfounders, etc.

Sir William Arrol & Company have constructed in Messrs. John Brown & Company's yard, at Clydebank, two very high electric derricks, designed to raise a load of five tons to a height of 120 ft. from the ground level, with a working radius of 35 ft.

The London and North-Western Railway Company have now practically completed the erection of their new workshops at Lancaster. The machine room will be 106 ft. by 39 ft. 7 in., the joiners' shop 68 ft. by 35 ft., and the smithy 53 ft. by 34 ft.

The St. Helens Cable Company, Limited, of Warrington, have removed their establishment at Newcastle-on-Tyne to 33, Clayton Street West. The company have closed their Edinburgh branch and transferred it, with the Glasgow branch, to new premises at 191, Howard Street.

George Saxon, Limited, has been registered to acquire the business carried on by the late G. Saxon, at Openshaw, Manchester, and to carry on the business of iron, steel, and brassfounders, etc. The registered office is at Openshaw Engineering Works, South Street, Ashton Old Road, Manchester.

Yarrow & Company, Limited, the well-known Poplar shipbuilding and engineering firm, have now completed their arrangements for establishing a new shipyard and engine and boiler shops on a site at Scotstoun, near Glasgow, to which they will remove when they leave their present works at Poplar.

Messrs. C. A. Parsons & Company, of Heaton Works, Newcastle-on-Tyne, are supplying their turbo blowing engines to the Consett Iron Company, Limited; Walter Scott, Limited, Leeds Steel Works; James Dunlop & Company, Clyde Iron Works; the Blaenavon Company; and the Dalmellington Iron Company.

W. & T. Avery, Limited, Soho Foundry, Birmingham, have now under construction for the Birmingham University Engineering Section a huge machine for testing whole members of constructional work, such as complete girders, columns, roof principals, etc. The machine is designed to test specimens for tension, compression, and transversely. The maximum capacity is 300 tons, the total length 70 ft., and the weight of metal in the machine is about 85 tons.

It has been rumoured that C. & W. Walker, Limited, had decided to close their foundry at Donnington, Shropshire, and to discontinue the manufacture of castings. We are informed, however, that this is entirely unfounded, the foundry being only temporarily closed to allow of extensive alterations and improvements necessitated by the rapid increase in the company's business. Arrangements have been made with local foundries to produce all the castings required to Messrs. Walker's own patterns.

We have received from Sir James Lang & Sons, Limited, Deptford Yard Brass Works, Sunderland, a capital little pamphlet descriptive of their gun-metal steam wheel valves, containing two illustrations. These valves are suitable for a working steam pressure of 100 lbs., and are carefully tested by steam pressure before leaving the Company's works. The Company are also manufacturers of brass castings up to ten tons in weight, iron castings, cast-iron corrugated steam heaters for ships' berths, etc.

——o——

PERSONAL.

Sir Andrew Noble, who has been seriously indisposed, is making capital progress towards recovery.

Mr. J. D. Ellis, chairman of John Brown & Company, Limited, who has been seriously ill, is very much better.

Mr. Andrew Carnegie has decided to write and publish a full history of his own life.

Mr. W. Panter, carriage and wagon superintendent to the London and South-Western Railway, has retired.

Sir W. H. Houldsworth, Bart., has resigned his directorship of the London and North-Western Railway Company.

Mr. E. H. Linley, of St. Louis, U.S.A., has been elected a director of William Jessop & Sons, Limited.

The late Mr. C. Seager, of Messrs. L. J. & C. Seager, Dartford Iron Foundry, has left estate valued at £6,300.

Mr. T. H. Deakin has been elected President of the South Wales Institute of Engineers.

Mr. S. Kershaw has resigned the management of the ironfoundry of Hartley & Sugden, Limited, boiler-makers, Halifax.

Mr. M. Mordey, a director of Messrs. W. A. Baker & Company, engineers, Newport, has resigned, and has been succeeded by Mr. J. Liscombe, of Newport.

Mr. G. Westinghouse, of Pittsburg, Pa., has been awarded the John Fritz Medal for the invention and development of the air brake.

A memorial tablet of Henry Cort, one of Lancashire's numerous and distinguished inventors, has been presented to the Manchester University by Mr. J. P. Bedson.

Mr. F. Lord presided at a dinner held in London recently, to celebrate the thirtieth anniversary of his connection with the firm of W. F. Dennis & Company, of which he is now senior partner.

Mr. W. J. Morris, head draughtsman to the Sheepbridge Coal and Iron Company, Limited, has been appointed manager and engineer to the Butterley Company.

Mr. G. B. Waterhouse, who has read many papers before the Iron and Steel Institute, has been appointed metallurgist to the Lackawanna Steel Company, Buffalo, N.Y.

Mr. H. Brock has been elected President of the Glasgow Chamber of Commerce in succession to Dr. William Jacks, and Mr. T. McArlay has been elected Vice-President.

Mr. R. Hetherington and Mr. H. A. Wilson, who have been associated with Messrs. Wm. Jacks & Company, of Glasgow, for a number of years, have been admitted into partnership.

Subscriptions are being invited for the purpose of presenting a testimonial to Mr. J. M. Jack, general secretary of the Associated Ironmoulders of Scotland, for 27 years' service rendered to the Society.

Mr. A. E. Hopper, lately assistant works' manager to Ernest Scott & Mountain, Limited, has been appointed to a similar position in Sheffield at the works of Cammell Laird & Company, Limited.

The late Mr. R. S. Scott, of Scott & Company, Limited, engineers and shipbuilders, Greenock, N.B., and chairman of the Leeds Forge Company, Limited, left estate valued at £159,285.

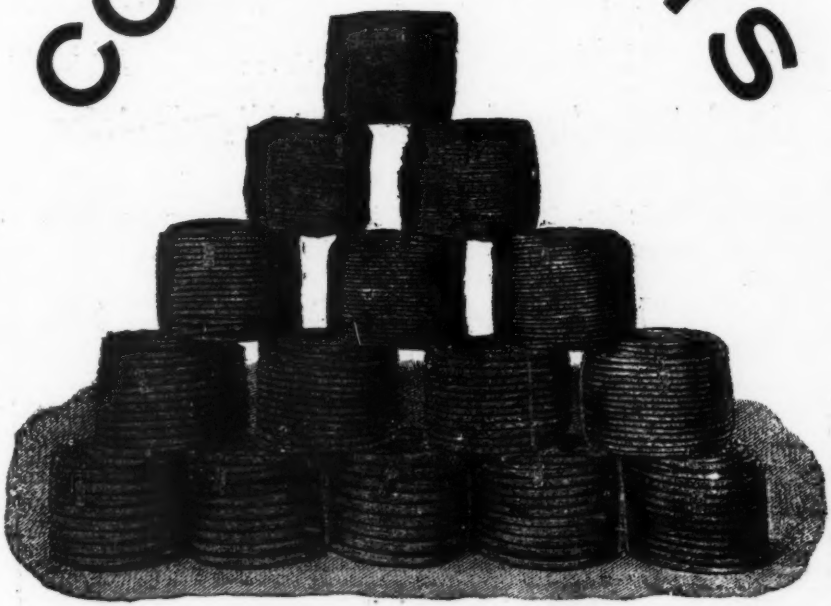
Mr. W. W. Storr, of Bolckow, Vaughan & Company, Limited, has been elected President of the Cleveland Ironmasters' Association, and Mr. J. J. Burton, of the Cargo Fleet Iron Company, has been chosen as Vice-President.

Mr. N. Weatherburn, the Midland Railway Company's locomotive superintendent for London and district, is shortly retiring. Mr. E. E. A. Talbot, the locomotive superintendent for Normanton and district, succeeds Mr. Weatherburn.

Mr. W. Ridley Makepeace has resigned his position as secretary of Head, Wrightson & Company, Limited, and accepted the appointment of general commercial manager for John Abbott & Company, Limited, Gateshead-on-Tyne. Mr. Makepeace was with Messrs. John Abbot & Company for 16 years, before going to Stockton-on-Tees in 1890.

EVANS'S

CORE VENTS



$\frac{1}{16}$, $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$ & $\frac{1}{2}$ diameter.

AS SUPPLIED TO H.M. GOVERNMENT

AND

ALL THE LEADING FOUNDERS.

JAMES EVANS & CO.,

Britannia Works,

MANCHESTER.

Telegrams { "LADLES, MANCHESTER."
"BLACKINGS, GLASGOW."

OBITUARY.

Mr. Benjamin Birks, the well-known authority on steel.

Mr. Robert Orr, well-known in the foundry trades of Glasgow.

Mr. Robert Knights, of Harleston, millwright, engineer, and ironfounder.

Mr. H. Bright, a well-known Sheffield steel die manufacturer, at the age of 77.

Mr. G. H. Geddes, senior partner of Messrs. J. & G. H. Geddes, mining engineers, Edinburgh.

Mr. C. H. Oakes, senior partner in the firm of James Oakes & Company, the Derbyshire ironfounders, at the age of 82.

Mr. E. Beddow, one of the directors of the Staveley Coal and Iron Company, Limited, at his residence at Southport, after a somewhat protracted illness. Mr. Beddow was also a director of the Parkgate Iron and Steel Company, Limited.

—o—

Mr. J. Bissett, cashier to R. B. Tennett, Limited, Whifflet Foundry, Coatbridge, has been the recipient of a presentation from the officials and men on the occasion of his marriage.

Ganister, Cupola Blocks, Fire Bricks,

Fire Clay.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

Steel Moulders' Composition, Silica Cement.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

ELDERS FOUNDRY COKE

As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

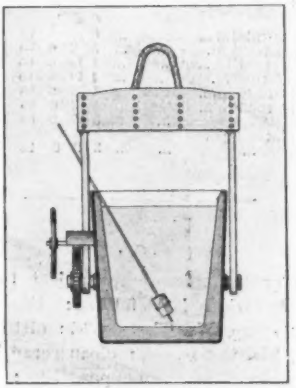
From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

PREVENTION OF BLOWHOLES IN CAST IRON.



A tin of our special compound fixed on a rod is held at bottom of ladle as shown; a strong re-action being thereby set up frees the iron from gases and impurities, which rise to the top.

RESULT: A denser casting of finer grain with increased strength.

For Particulars apply to—

THERMIT LIMITED,

27, MARTIN'S LANE, CANNON STREET,

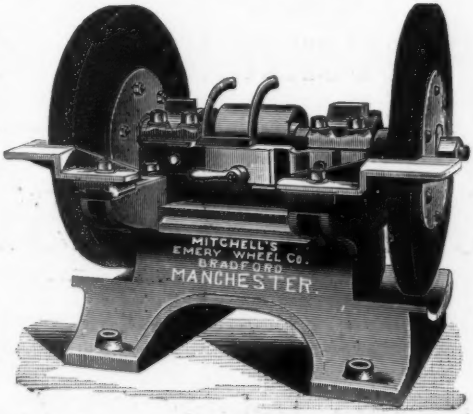
Telephone—3749 Central.
Telegrams—"Fulmen," London.

LONDON, E.C.

MACHINES. For all Purposes. **WHEELS.**

Complete with Emery or Corundum Wheels from **£2** upwards.

Special Machines Designed.



Emery or Corundum from 1 in. x $\frac{1}{8}$ in. to 50 in. x 12 in.

Enquiries solicited.

MITCHELL'S EMERY WHEEL Co.,

Mill Street, Bradford, MANCHESTER.

Also at LONDON, GLASGOW, and BELFAST. LISTS FREE.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1905-6.	1904-5.
Iron—Scotch pig warrant ... ton	.... —	..... —
—Middlesbro' warrants ... ... ton	..... 48/11	..... 49/9
—W.C. M/nos Bessemer ... ... ton	..... 70/0	..... 57/6
—Stock, Scotch, Mar. 1 ...tons	 14,300	 14,440
Copper—Chili bars, GMB ... ... ton	..... £78 17/6	..... £68 7/6
—Stock, Europe & afloat... ... tons	 10,235	 17,125
Tin—English ingots ton	..... £167 0/0	.... £134 0/0
—Straits ... ton	..... £165 15/0	..... £131 10 0
—Stock, Ldn. Hind and aft ... tons	..... —	.... —
Lead—English pig ton	..... £16 5.0	....£12 11 3
Spelter—Ord. Silesian ... ... ton	..... £25 2/6	..... £24 0 0
Quicksilver—(75lb.) bottle	.... £7 7/6	.... —
Antimony—Regulus ... ... ton	..... £63 0/0	..... —

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 12 6	to	7 2 6
Pipes, 1½ to 2½ in.	5 2 6	to	5 5 0
,, 3 to 4 in....	4 15 0	to	4 17 6
,, 5 to 8 in.	4 12 6	to	4 15 0
,, 10 to 16 in....	4 12 6	to	4 15 0
,, 18 to 24 in....	4 12 6	to	4 15 0
Chairs	3 15 0	to	3 17 6
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotation for scrap subject to market fluctuations is as follows: —Engineers' heavy scrap, 57s. 6d. to 60s.; ditto light scrap, 25s. to 27s. 6d.; clean scrap brass, 47s.; clean scrap copper, 73s.; lead (usual draft), 14s.; tea lead, 12s. 6d.; zinc, 19s.; hollow pewter, 105s.; black pewter, 70s. per cwt.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

GROUND GANISTER,

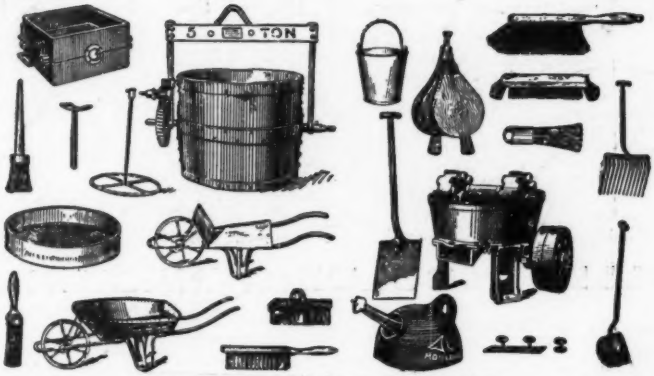
Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Better than Fire-clay Bricks for Cupolas.

Established 1863.

Jas. Durrans & Sons,



PHŒNIX WORKS, PENISTONE,

Nr. Sheffield.

Manufacturers of all

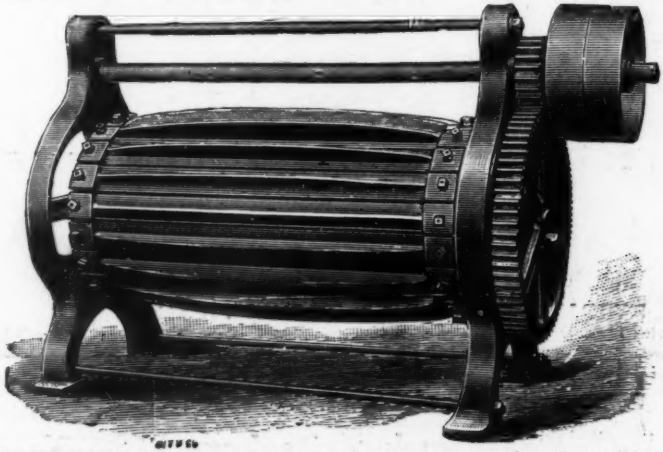
FOUNDRY EQUIPMENTS

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

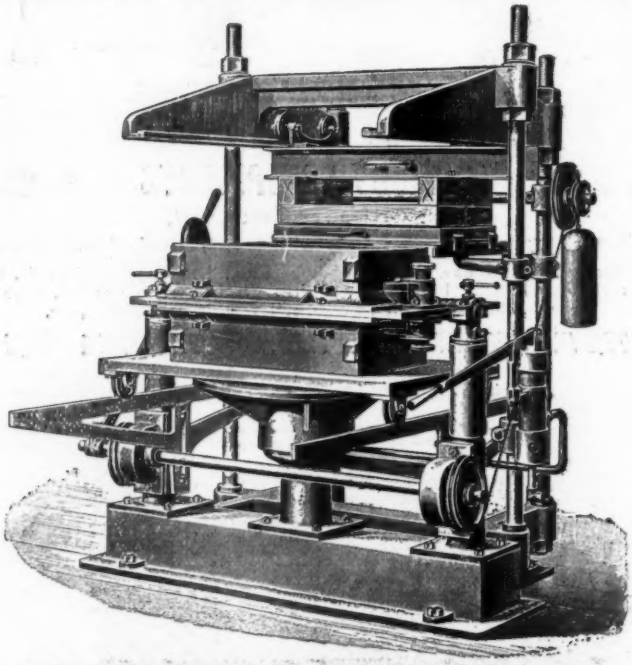
Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

PULLEY MOULDING MACHINES.



HYDRAULIC MOULDING MACHINE, Pattern "L,"
with Turn-over Pattern Plate, suitable for Deep Castings and General Work.

The LONDON EMERY WORKS CO.,

Telephone: 99 Tottenham.
Telegrams: "NAXIUM," London.

Park, Tottenham, LONDON, N.

SITUATIONS VACANT AND WANTED.

METALLURGIST and Analytical Chemist with £2,000 desires position in sound concern. Replies to Box 4,663, Judd's, 5, Queen Victoria St, E.C.

TRAVELLER WANTED, with good connection amongst advertisers of engineering goods. Liberal salary and commission. Address Box 320, T. B. Browne's Advertising Offices, 163, Queen Victoria Street, London.

FOR SALE AND WANTED.

FOR SALE, "Root's" Patent and other Foundry Blowers.
No. 2A size by "Daglish," Glasgow, 4½ in. outlet
No. 1A ,, ,, "Allday," Birmingham, 6 in. ,,
No. 3 ,, ,, "Wilkinson's" Patent, 6 in. ,,
No. 5 ,, ,, "Thwaites" ,, 14¾ in. ,,
"Lloyd's" Patent Fan as new, 8 in. ,,
—For full details address J. LIGHT, Wolverhampton.

LIME.—HYDRAULIC LIME suitable for concrete, also for building purposes, foundries and gas works.—THOS. MOAKES, Stanton Hills, Mansfield.

E. APPLEBY, Orange Street, Sheffield, for Steel Files, Hammers, Chisels, Tools, etc.

CRUCIBLE STEEL CASTINGS for Collieries, Works, and Engineers, from customers' patterns; machined if desired.—P. T. WOODRUFF AND CO., Machen, Newport, Mon.

FOR SALE, Ovoid Briquette Plant to turn out 20 tons per day 5 oz. Briquettes, complete with Disintegrator, Elevator, Mixer, and Conveyor.—Apply, J. S. HALL & CO., LTD., Midland Ironworks, Newark-on-Trent.

ROOTS BLOWERS.

Two Belt-driven, Number 4, by Thwaites Bros.
One Engine combined, Number 4, with No. 5 Engine, by Thwaites, Bros.,

FOR SALE.

Can be inspected at JOHN ADAMS & SONS, Machinery Stores, Newcastle-on-Tyne.

FOR SALE.

Scott's Wheel Moulding Machine, equal to new.
New 3 ft. 6 in. and 4 ft. 6 in. pan, Loam and Sand Mill.
New Moulding Sand Mixer. Capacity, 5 to 10 tons per hour.
Thwaite's Root's Blower, 11½ in. discharge.
Thwaite's Root's Blower, combined with Vertical engine. Melting capacity, 3 tons per hour.
No. 4 Root's Blower, by Alldays, to blow 50 fires.
30 in. Revolving Blast Fan.
No. 3 Sturtevant High-pressure Fan, 24 in. diameter.
No. 1 Silent Blowing Fan, suitable for 7 fires, 11 in. diameter.
Blowing Fan by Lloyd, 36 in. diameter.
New Patent Noiseless Fan ... for 9 fires.
Do. Do. ... for 2 fires.
Do. Do. ... for 6 fires.
Do. Do. ... for 4 fires.
Do. Do. ... for 8 fires.
Do. Do. ... for 12 fires.
Two New Patent Noiseless Fans for 16 fires.
Two Exhaust Fans, 5 in. and 6½ in. inlet.

Send for Illustrated List of Phillip's New Improved Foundry CORE OVENS.

IRON AND BRASS CASTINGS.

Note the ONLY ADDRESSES:—

CHARLES D. PHILLIPS,

Emlyn Engineering Works and Foundry, NEWPORT, MON., AND GLOUCESTER.

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Foundry Specialists.

GANISTER, FIREBRICKS, GANISTER BRICKS, FIRECLAY,
Of the Highest Qualities.

If you are troubled with Defective Fire-Resisting Materials write for Prices.

SHIPPING PORTS:
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MOULDING SAND
FOR
ALL METALS.

The noted Birmingham quality is sent all the World over.

For Prices—

J. WILLIAMS,

ICKNIELD SAND MINES,
BIRMINGHAM.

Also Manufacturer of Fine Grade Coal Dust and Foundry Blackings.

DIRECT MOTOR-DRIVEN

FAN BLOWERS.

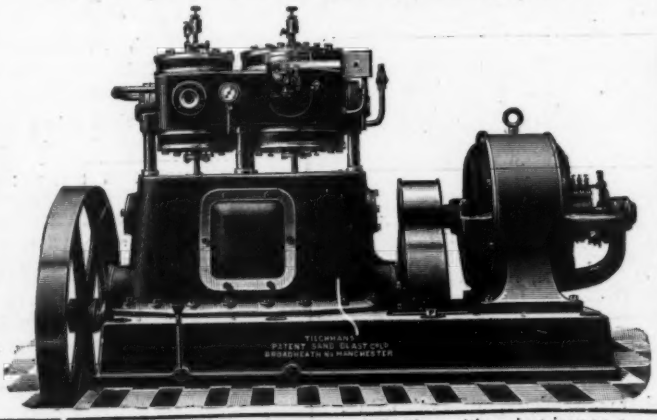
Lists and full particulars on application.

ALLDAYS & ONIONS,
Pneumatic
Engineering Co.,
Ltd.,
BIRMINGHAM.

AIR COMPRESSORS

DRIVEN BY STEAM, BELT, OR ELECTRICITY.

HORIZONTAL & VERTICAL.
Single Stage & Compound Types

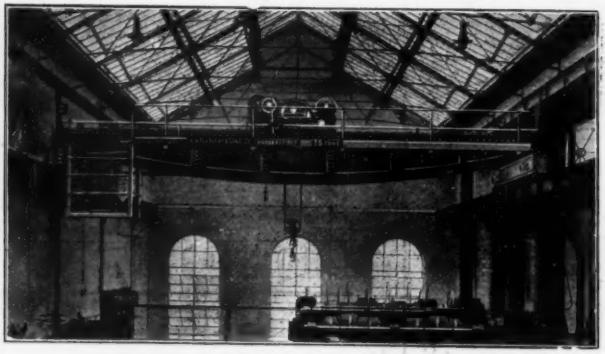


High efficiency, Silent working and 12 months guarantee.

SAND BLAST APPARATUS for cleaning large & small Castings, either steel, iron or gun metal.

Tilghman's Patent Sand Blast Company, Ltd.,
BROADHEATH, near MANCHESTER.

ELECTRIC CRANES!



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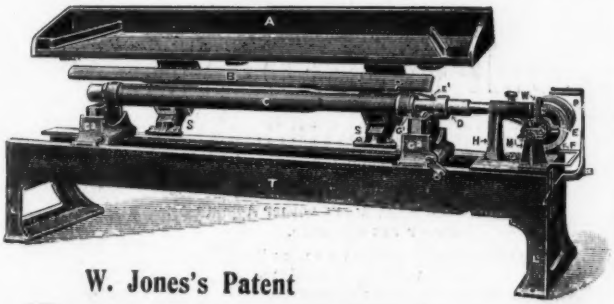
TONS
Capacity.

Send for
our New
Catalogue.

THOMAS BROADBENT & SONS, Ltd.,
HUDDERSFIELD.

A REVOLUTION IN
Pipe Foundry Practice

For
Pipe Cores,
18 ft. long and
2 in. to 20 in.
diameter.



W. Jones's Patent
CORE FORMING MACHINE

JONES & ATTWOOD,
STOURBRIDGE, ENGLAND.

MOULDING SAND
FOR
ALL METALS.
The noted Birmingham quality is sent all the World over.

For Prices—
J. WILLIAMS,
ICKNIELD SAND MINES,
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Also Manufacturer of Fine Grade Coal Dust and Foundry Blackings.

PATENT CORE MAKING MACHINES
No linseed oil or flour required.
NEW PORTABLE MOULD DRIERS
Moulds dried on the spot in an hour to one hour and a half.
ECONOMY WIRE WHEEL BRUSHES
for cleaning castings. Wire easily replaced by the user.
J. W. & C. J. PHILLIPS,
23, COLLEGE HILL, London, E.C.

STIGNIC PAINT.
NEWEST AND BEST WASH FOR STEEL FOUNDERS
PLASTIC CUPOLA GANISTER.
FINEST MATERIAL FOR LINING CUPOLAS AND FURNACES AND SETTING FIRE-CLAY BRICKS.
SPECIAL STEEL MOULDERS' COMPO.
STEPHENS & CO., Kidwelly.

COLD BLAST PIG-IRON.

M. & W. GRAZEBROOK,
DUDLEY.

£100
WILL BUY
A COMPLETE
COMPRESSED AIR
INSTALLATION,
INCLUDING
"Boreas" Air Compressor, Receiver, Chipping Hammers, Hoists, Sand Blast Apparatus or other Appliances.
ALL OF THE BEST KIND.
Every works should possess one, as it will pay for itself in a very short time.
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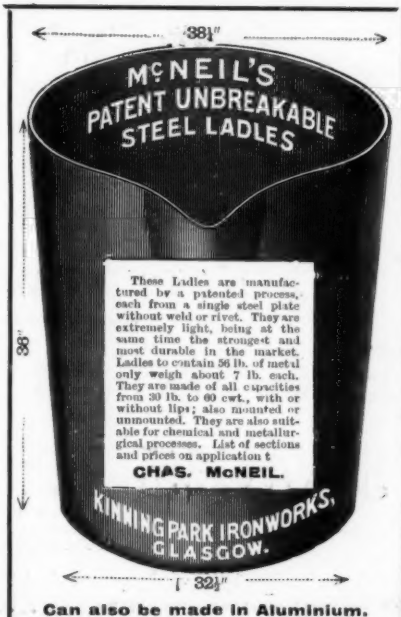
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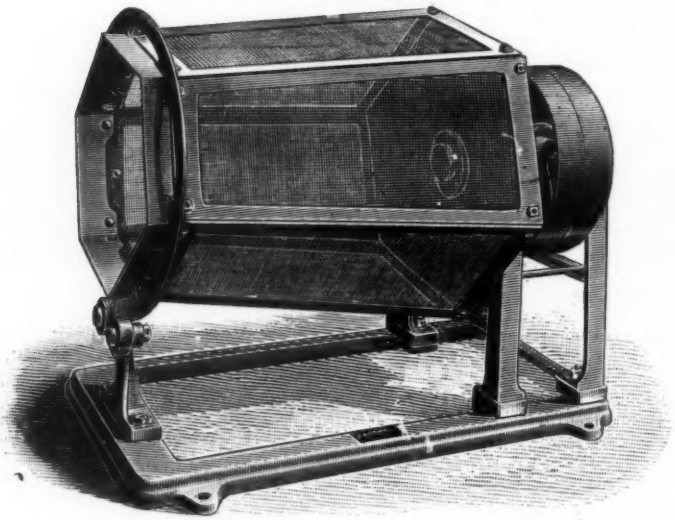

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